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AND ABSTRACT OF THE LITERATURE

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HONORARY CONSULTING EDITOR
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A Method for Determining the Finer Dust Particles in Air

Aniline Poisoning in the Rubber Industry

Oil Folliculitis

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THE JOURNAL OF INDUSTRIAL HYGIENE

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THE PREGNANT WOMAN IN INDUSTRY*

CAREY P. McCORD, M.D., AND DOROTHY K. MINSTER

Cincinnati, Ohio

THE pregnant woman, her physician, and her employer, all have need of a better understanding of pregnancy in relation to work. The government, employers, and labor bodies are continually seeking to surround the woman worker with conditions that enhance her economic worth and are favorable to the maintenance of her health. These agencies have, however, failed properly to appreciate the fact that the normal pregnant woman is capable of work, and as a result have neglected the specific provisions that would make it possible and advantageous for her to continue at work.

In the industries of this country about five million women are employed, nearly one million of whom are married. An unknown but obviously large number of pregnancies occur every year among them. At this time of additional expenses preparatory to the child's birth and to after-care, an even greater necessity for earning money arises. Many times it is of mutual advantage to the employer and to the pregnant employee to allow her to continue her work as long as it is not harmful to her or to her unborn child. Through lack of dependable advice, it is the tendency of the expectant mother, especially the primipara, to discontinue work early in her pregnancy. She is influenced in her decision to do so by her apprehension lest in some way she harm her child; by gossip current among older women as to the disastrous effects of work; by her fear that in the plant she will become the butt of idle humor; by the fact that the mental and physical discomforts of pregnancy are at their height in this early period, thus leading her to think that she will continue to be too "miserable" to work. The employer, knowing little about the matter, "plays safe" and acquiesces in her decision, thus needlessly losing the services of a valuable worker.

There is great need of competent medical supervision by physicians who are not only well qualified as obstetricians but who are also well acquainted with trade processes, occupational hazards, fatigue and posture problems, chemical intoxications, and the like. Unfortunately, the physician serving this group of patients is very often wholly unacquainted with industrial medical matters and therefore incompetent to discriminate between suitable and unsuitable plant work. Too much is sacrificed, both by the woman and by the employer, through this lack of scientific knowledge as to the desirable work environment for the pregnant employee.

The approaches to the problem, which

* Received for publication Jan. 14, 1921.

TABLE 1.—MATERNITY BENEFITS

Country or State	Date of Law in Force	Types of Benefit				Source	Amount
		Money in Lump Sum	Money in Instalments	Medical, Nursing, Institutional Care	Payment for Breast Feeding		
Australia	1912	+	..	..		government	$25 total
Austria	1917	..	+	+	½ amount for maternity benefit to end of 12th week	insurance premium — ⅓ employer, ⅔ employee	60% of standard rate of wage class to which insured belongs
Denmark	1915	..	+	if necessary		insurance society; government	$0.27 daily
France	1913 with subsequent amendments	to government employees only	+	..	$2.70 at end of 4 weeks	government; mutual aid societies	$0.096 to $0.29 daily
Germany	1911	special wartime measure $5.95	+	substitute for maternity benefit if desired	½ cash benefit for 12 weeks; doubled for twins	insurance premium — ⅓ employer, ⅔ employee	$1.19 to $1.43 daily
Great Britain	1912	+	..	cash benefit may be used in this way		government insurance premium, employer and employee	$7.20 if woman is insured; $14.40 if husband is also insured
Italy	1912—modified in 1917	+	..	..		insurance premium — ½ employer, ½ employee	$7.72 in two instalments
Luxemburg	1902	..	+	..		insurance premium — ⅓ employer, ⅔ employee	cash benefit of ½ daily earnings
Netherlands	1913 — not in effect on Jan. 1, 1918	..	+	+		insurance premium — ½ employer, ½ employee	70% of average wage until after childbirth; then 100%
New Zealand	1911	+	..	+		government insurance — ¼ government, ¾ insured	not more than $29.20
Norway	1915	+	+	+		insurance premium — 6/10 insured, 1/10 employer, 3/10 gov't	60% of daily wage
Russia	1913	..	+	+		owners of establishments; insured; donations, fines, etc.	½ to full wages
Sweden	1913	..	+	..		government	$0.24 daily
Switzerland	1914	+	..	+	$3.86 if mother has nursed child for 10 weeks	dues of members, subsidy of state	$3.86 lump sum
Colorado	1913	..	..	..		government	enough to care properly for child
Missouri	1917	..	..	..		government	one child, $16 monthly; $10 for each additional child
Pennsylvania	1919	..	..	..		government	one child, $20 monthly; $10 for each additional child

TABLE 1. — MATERNITY BENEFITS

Country or State	Time Limit		Persons Included According to		Remarks
	Before Confinement *Weeks*	After Confinement *Weeks*	Occupation	Wage Class	
Australia			unlimited except for natives and Asiatics	unlimited except for natives and Asiatics	medical certificate necessary to exclude stillbirths and abortions
Austria		6	establishments using power or explosives; under industrial code; building trades; transportation	workers receiving less than $487.20 a year	present conditions unknown
Denmark		10 days, after which she is entitled to usual sick benefit		workers without income-bearing property; over 15 years of age	only slight changes in law of 1892 because of "financial straits"
France	as indicated for mother, not more than 4	4	all wage earners except rural workers		1917 law provides for wives of soldiers regardless of being wage earners
Germany	2	medical certificate required before return to work	all wage earners	others if income is less than $5.95 yearly	wartime measures providing special maternity benefits
Great Britain		4	manual employment; non-manual if income is less than $776.64	workers receiving less than $778.64 yearly	pregnancy benefit; British system most complex of all because of numerous perplexing features
Italy		4	industries, factories; private telephone companies; government employees excluded		nursing room for mothers in factory; no distinction between married and unmarried mothers
Luxemburg		4	wage earners	salaried employees receiving less than $1.93 daily	
Netherlands	unlimited during entire period of disability		regularly employed	to be specified later	no distinction between legitimate and illegitimate children
New Zealand				all over 16 and under 45 years, receiving less than $1,000 yearly	maternity benefit a part of old age and invalidity insurance
Norway	2	6	all wage earners and salaried employees over 15 years	workers receiving less than $482 yearly	admirable provisions for illegitimate child
Russia	2	4	all wage earners in factories using mechanical or animal power		requires owner to furnish hospital care; present conditions unknown
Sweden		2			information incomplete
Switzerland		6	all industries and occupations		maternity benefits of this country have served as a model to many others
Colorado			mothers unable to care for children specified period, before and after childbirth		mothers' pension fund
Missouri	3	3	unlimited		mothers' pension fund
Pennsylvania			additional sum for unborn child if mother is already receiving pension		mothers' pension fund

have thus far been made, have been largely blanket provisions without consideration of the individual case with its specific problems of work environment, health, etc. The few measures in practice are chiefly the outcome of the activities of governments and labor bodies. In accepting some responsibility for the pregnant woman in industry, these agencies have adopted two general methods of procedure: (1) the prohibition of employment of women on any work during specified periods of gestation, the prohibition of employment of any women in certain trades, and the regulation of conditions of employment for women at work; (2) the provision of maternity benefits, thus making the necessity for work less frequent.

Although these existing measures are distinctly helpful, they are palpably inadequate. Obvious shortcomings arise from the failure to provide medical guidance throughout pregnancy and from the failure to determine more definitely the influence of specific work conditions upon maternity.

Maternity Benefits and Legal Control of the Pregnant Woman's Work

Is the pregnant working woman jeopardizing her health by continuing work after the onset of pregnancy? Is the well-being of her child jeopardized by her working? When should the pregnant worker discontinue work? Are there certain occupations and types of work that are especially harmful? Is the fact that she is to give birth to a child of such economic importance that she is entitled to some form of compensation? In this country such questions have until recently occasioned no deep concern and only five states have laws definitely pertaining thereto. Fifteen other countries are far in advance of the United States — namely, Great Britain, France, Italy, Australia, New Zealand, Germany, Austria, Hungary, Denmark, Norway, Sweden, Roumania, Servia, Switzerland, and Russia.*

Maternity Benefits (1).—In most foreign countries, maternity benefits are included in systems of social insurance, are usually compulsory, and are designed to protect the health of the mother and child by providing moneys and medical and nursing care before, during, and after childbirth. By so doing, the financial burden of childbearing is lessened and the mother is assured freedom from the necessity of excessive work for a reasonable period of time. These insurance systems usually consist in one of the following four types or in a combination of certain features of these types:

1. A fixed sum is paid at the birth of the child — the state supplying the funds.
2. Insurance systems to which the woman, her employer, and the government contribute.
3. The continuation by the employer of a portion of the wages of the woman — usually from 50 to 75 per cent.
4. The provision of medical and nursing care prior to, at, and after delivery.

Table 1 is a tabulation of the major provisions found in the maternity benefit system in force in various countries, and in a few states within the United States. In the countries indicated in this table, particular features in the treatment of the problem are noteworthy. In a few of the countries, the maternity bonus is available to every mother irrespective of her economic status. In others, only urban workers participate in the provisions on a compulsory basis. In certain countries the type of work or the amount of the wage limits the persons who are included. The unmarried mother is excluded from all benefits in a high percentage of the national laws. In some instances, race prejudices lead to the exclusion of mothers of designated nationalities. During the war some countries extended their

* Conditions in certain of these countries may have disrupted the application of existing maternity benefit measures.

TABLE 2. — LAWS PROHIBITING EMPLOYMENT OF PREGNANT WOMEN

State or Country [1]	Date	Industries Included	Time Limit	
			Before Confinement *Weeks*	After Confinement *Weeks*
Vermont		mill, cannery, workshop, factory, manufacturing or mechanical establishment	2	4
Connecticut	1913	factory, mercantile establishment, mill or workshop	4	4
Massachusetts	1911	mercantile, manufacturing or mechanical establishment	2	4
New York	1912	factory, mercantile establishment, mill or workshop	no provision	4
Austria	1917	establishment using power or explosives, building trades, establishments in industrial code, transportation		6
Denmark [2]	1901	any factory work		4
France	1913	industrial or commercial undertaking		4
Great Britain	1911	remunerative employment		4
Germany [3]	1908		2	6
Italy	1907	factories, agriculture, etc.		4
Norway	1915	industrial establishments	4 (must be permitted to stop work)	6
Sweden	1891	industrial establishments		4 [2]
Switzerland	1877	industrial establishments	2	4

[1] According to unauthentic information the state of Washington prohibits the employment of women 2 months before and 6 weeks after confinement.

[2] Unless she has doctor's certificate.

[3] Medical certificate required at end of 6 weeks.

provisions so as to encourage child-bearing and to relieve the wives of soldiers and government employees.

Restrictive Measures. — Practically all industrial countries have promulgated laws forbidding the employment of women in various hazardous trades and restricting the hours and time of work. These laws, although not primarily designed as protective of the pregnant woman, are distinctly beneficial to maternity. In addition, a limited number of states and countries have devised laws applying peculiarly to the pregnant woman. Switzerland was the leader in legislation of this kind. In 1877, the National Council prohibited the employment of pregnant women in industrial plants for a period of eight weeks, a part of which was prior to and the rest subsequent to delivery. The essential features of this type of legislation in various countries are grouped in Table 2.

At the time of the International Labor Conference held in Washington, D. C.,

November, 1919, the following draft convention with reference to the pregnant working woman was adopted:

ART. 3. — In any public or private industrial or commercial undertaking, or in any branch thereof, other than an undertaking in which only members of the same family are employed, a woman

(*a*) Shall not be permitted to work during the six weeks following confinement.

(*b*) Shall have the right to leave her work if she produces a medical certificate stating that her confinement will probably take place within six weeks.

(*c*) Shall, while she is absent from her work in pursuance of paragraphs (*a*) and (*b*), be paid benefits sufficient for the full and healthy maintenance of herself and her child, provided either out of public funds or by means of a system of insurance, the exact amount of which shall be determined by the competent authority in each country, and as an additional benefit shall be entitled to free attendance by a doctor or certified midwife. No mistake of the medical advisor in estimating the date of confinement shall preclude a woman from receiving these benefits from the date of the medical certificate up to the date on which the confinement actually takes place.

(*d*) Shall in any case, if she is nursing her child, be allowed half an hour twice a day during hours for this purpose.

ART. 4. — Where a woman is absent from her work in accordance with paragraphs (*a*) and (*b*) of Article 3 of this convention, or remains absent from her work for a longer period as a result of illness medically certified to arise out of pregnancy or confinement and rendering her unfit for work, it shall not be lawful, until her absence shall have exceeded a maximum period to be fixed by the competent authority in each country, for her employer to give her notice of dismissal during such absence, nor to give her notice of dismissal at such a time that the notice would expire during such absence.

The shortcomings of all such measures lie in (1) the scant provision made for the supervision of the health of the pregnant woman throughout the gestation period; and (2) the lack of investigation seeking to determine the effects of specific trades and occupations upon maternity.

HYGIENE OF THE PREGNANT WOMAN

The pregnant woman is admittedly better off in a normal home environment than at work in a factory. With the proper guidance and supervision, however, it will not be harmful for the pregnant woman to work if work is an economic necessity for her. For those who must work, then, better health supervision and general guidance must be evolved.

Is Work Harmful? — There are many opinions as to the harmfulness of work for the pregnant woman. Many years ago, Jones(2) stated that "the pregnant woman should not be employed in industrial occupations." More recent opinions hold that work of the proper sort is definitely good for the normal pregnant woman. All books on obstetrics and all directions for the hygiene of the pregnant woman recommend mild exercise and fresh air. Industrial work may meet all these requirements. For instance, Paradise (3) states that "ordinary housework and many of the chores on a farm afford mothers the opportunity for necessary exercise." This is, of course, not factory work but there is much factory work less arduous than these domestic duties. In the usual factory there are many occupations which are less harmful than some housework; at the same time, it is true that there are many processes not at all suited to the pregnant worker. On the whole, we can accept the principle laid down by De Lee (4): "In a general way the gravida should not change her usual mode of life unless the physician knows that some of her habits are bad."

Medical Examination. — All these opinions apply to the normal pregnant woman. The crux of the situation, then, is to determine whether the pregnant woman is normal and to keep a close watch over her, so that her work may be regulated to suit her limitations. If proper industrial medical service is maintained, she should be encouraged to consult the doctor as soon as pregnancy is suspected. If the doctor confirms her suspicion, a thorough examination should then be made. The industrial physician is usually not competent to carry

out a satisfactory obstetrical examination, nor is the average practitioner so qualified. Upon detection of pregnancy, therefore, the worker should be referred to a suitable clinic or to an obstetrician. It is unnecessary to describe here the nature of the examinations which should be made. After the initial examination, however, subsequent examinations should be made when recommended by the obstetrician. At the very least, a complete examination should be made during the eighth month of pregnancy.

Although the industrial physician may not be qualified to make specific obstetrical examinations, there are many other requirements for the general health of the pregnant woman which he can fulfil. For instance, one obstetrician emphasizes the necessity of watching the teeth and bony structures which are likely to be affected because of the alteration of the phosphates of these tissues.

Full co-operation should exist between the plant physician or employment manager and the specialist. In this way only can the obstetrician know of the nature of the woman's work and thus be guided in his recommendations to the plant physician or employment manager. A great responsibility rests with the plant physician in his having a complete knowledge of trade processes, occupational and safety hazards, and suitable replacement jobs when they are necessary. Constant supervision should be exercised throughout by the plant physician. In a particular munition factory in England during the war, the women received very careful supervision and a definite routine was adopted. Upon notification of pregnancy the women were given suitable work, and as pregnancy progressed they were changed from time to time to work that was even better adapted to their needs. At the end of the seventh month, the pregnant woman was transferred to a particular room known as "the general clothing store and sewing depot." While she was at work in this room she was visited every week by a physician who examined a specimen of the urine and made other examinations. The work was so arranged that the women could remain at work until just before parturition, without harm to themselves or to the work (5).

Accident Risk. — By means of such careful supervision, the risk which an employer assumes in keeping a pregnant woman in his employ is reduced to a minimum. No statistics are obtainable as to the frequency of accidents among pregnant industrial workers. A knowledge of the physical alteration and the mental preoccupation of the pregnant woman, however, makes tenable the assertion that she is much more liable to industrial accident than the non-pregnant worker. Late in pregnancy locomotion is hampered through the changed posture made necessary by her adjustment to her shifted center of gravity. This leaning backward not only alters locomotion but is likely to prevent her from seeing where she is stepping. Since accidents growing out of such circumstances commonly occur to the pregnant woman in her home, we may expect such mishaps as falling over obstructions in passageways and downstairs to be no less common in the factory. Accidents of this kind frequently result in miscarriage. Consequently, the employer is incurring some liability in retaining in his employ women in an advanced stage of pregnancy.

Abortion and miscarriage, it must be remembered, are more frequent during the early stage of pregnancy and are due most often to causes in no way connected with the work environment. In one factory where a study of pregnant women was made, among 101 pregnant women in nine months, there were fifteen miscarriages, thirteen of which were abortions occurring between the fifth and tenth weeks. Of the two miscarriages, one was caused by an operation for carcinoma of the cervix, and the other was due to syphilis contracted

during the sixth month of pregnancy. Of the thirteen abortions, one fell out of bed, one fell downstairs (the report does not state whether at home or in the factory), one had tuberculosis, and one had had previous miscarriages. There are no facts as to the etiology of the other nine, but from these six it is apparent that the greater risk arises before the employer has been notified—that is, before pregnancy is definitely established.

As is well known, carelessness is the great cause of accidents. Continual vigilance on the part of all workers is the best safety device. In the case of the pregnant worker, a concentration on her immediate work and its hazard is more difficult, because she is continually mulling over her abnormal relations with other people and the circumstances attending her pregnancy and anticipated confinement. The recognition of the fact that the pregnant woman is an increased accident risk should not lead to her elimination from the plant but rather to her placement in non-hazardous occupations and to additional education in precautionary measures.

Harmful Occupations. — Throughout the discussion of what work is injurious to the pregnant woman, it must be remembered that any conditions which are bad for the normal woman worker are even worse for the pregnant worker. This statement applies to the hours of employment as well as to general working conditions. If the work is wearing and the normal woman finds eight hours of work a strain, the pregnant woman should not be forced or allowed to work so long. The pregnant woman should never be allowed on a night shift. Night work generally means that the woman has so much to do at home in the daytime that she cannot go out to work. The pregnant woman cannot stand the strain of day work and night work in addition. There may even be certain times of the day when the pregnant woman cannot work because of her condition. For instance, if she suffers from morning nausea, she should be allowed to remain at home until such time in the day as she is able to take up her work.

A knowledge of what constitutes harmful conditions must be based on the individual case, that is, the woman and her particular job. There are, however, some general principles which can help the physician in determining suitable and unsuitable jobs for the pregnant woman.

Character of Work. — Generally speaking, any undue physical strain is bad for the pregnant woman. De Lee states that "jolts, running, sudden motions, lifting great weights, going up and down stairs quickly, etc., should be avoided." Dorland (6) states that "lifting of heavy weights, running upstairs and other violent forms of exercise must be strictly avoided lest miscarriage result." In an article in the *Monthly Labor Review* (7), there are reported five types of occupation which are harmful: (*a*) Continuous sitting has a bad effect at delivery as well as on the mother's health after confinement; (*b*) standing continuously is less harmful except that it tends to induce varicose veins; (*c*) lifting, reaching, and stretching up are universally bad during pregnancy; (*d*) jolting is bad, and also (*e*) work to which muscles are not accustomed.

TABLE 3. — TYPES OF OCCUPATION SHOWING TENDENCY TO PRODUCE BAD RESULTS AT PREGNANCY

Type of Occupation	Number of Women Employed during Pregnancy	Bad Cases	
		Number	Per Cent.
Active	213	83	39.0
Sitting	88	23	26.1
Standing	30	2	6.0

In Table 3 figures are given which bear out this statement of the evil effects of active occupations, sitting occupations, and standing occupations on the pregnant woman. Bad cases are those which had difficulty in some form or other before or at

the time of confinement. What the active occupations comprise is not stated but it may be assumed that lifting, reaching, and jolting are included. The percentage of bad cases is remarkably high in this group and, indeed, is very little lower in the sitting occupations. Although the figures show the standing occupations to be far less harmful than the other types of work, it must be remembered that only thirty women are considered — almost too low a number to be decisive. In a report on the *Proposed Employment of Women during the War in Industries of Niagara Falls* (8) certain conditions of work were specified which were more harmful to women, particularly in regard to their child-bearing function, than to men. Once again reference is made to lifting heavy weights, unusual stretching or straining, but more especially to continuous standing, as bad for women because of the difference in their body structure, in other words, the structure of their reproductive organs. If continuous standing is noticeably harmful for women in general on this account, how much more harmful is it for pregnant women in particular, who have an additional strain on these organs. Indeed, there can be no question that continuous standing is as harmful for pregnant women as any other of the specified forms of physical exertion.

The character of the work may involve a nervous strain as well as a physical strain. The mental attitude of the pregnant woman which causes her distraction, referred to above, is due to the fact that her whole nervous system is abnormal. She is morbid, sensitive, and at times hysterical. For this reason any undue strain on her nervous system is felt more than if she were normal. Monotony, speeding up, noise, vibration, a high degree of concentration, all cause a strain on the nervous system of the pregnant woman, which ought to be avoided.

Analysis of Work. — Keeping these general principles in mind, the industrial physician or the employment manager must set about analyzing his particular industry. He should examine each process at which women are employed, with a view to determining whether the worker is subjected to any of the strains enumerated above.

Specific recommendations in regard to occupations to be avoided by women were made in the survey of work at Niagara Falls. The Woman in Industry Service of the Department of Labor demanded the prohibition of the employment of women in (*a*) shoveling or wheel barrow work, (*b*) yard work, (*c*) loading or unloading freight cars, (*d*) lifting weights over 25 pounds. The first three types of work are obviously harmful but they serve to show a specific analysis of an industry. The fourth is of especial interest because it established a maximum lifting weight. The permitted weight is probably excessive and admittedly applies only to some women, and must be only an occasional process, not a continuous one. The recommendations of the Woman in Industry Service were made with reference to all women but they may be used as a gauge in the case of the pregnant woman.

Of more definite value in this regard is the survey of the textile industry (9). It was found that the mortality rate from puerperal infections and childbirth is higher in textile towns than in non-textile towns where there are not nearly so many married women employed. The U. S. Bureau of Labor Statistics made an investigation of preventable deaths in the cotton manufacturing industry, process by process. In the card room the work involves lifting bobbins weighing from 2 to 4 pounds each, and placing them on frames 5 to 6 feet high. This involves lifting and stretching — two of the physical strains to be avoided. The effect which this work has upon the married woman and consequently upon the pregnant woman is very evident when the statistics of deaths from various causes ac-

cording to conjugal state are examined. The deaths from tuberculosis among unmarried card room workers exceeded those of unmarried non-operatives by 93 per cent.; the deaths of married card room workers exceeded those of married non-operatives by 323 per cent. The deaths of unmarried operatives from non-tuberculous causes exceeded those of married non-operatives by 81 per cent. The report states that the high death rate of married operatives is influenced by the continued lifting of bobbins and placing them on frames above their heads. This process "may quite probably constitute a contributory cause of death from prematurely terminated pregnancy and from childbirth." In the spinning room, where the work demands constant walking or standing in a hot, moist atmosphere, the percentage of deaths of married operatives between the ages of 15 and 44 years from causes other than tuberculosis — parturition fatalities — is highest. The deaths from parturition number twenty-eight for operatives in this department as against five for non-operatives; or the death rate per 1,000 from this cause is 4.72 for operatives as against 0.53 for non-operatives. In the weave room, where the women do much bending over looms and generally carry the cloth weighing from 15 to 18 pounds to the scales, the death rate among the married women is very high.

In Table 4 the excess of deaths among married operatives over those among married non-operatives is appalling. The report throws some light on the cause of this excess in the following statement: "It will readily be appreciated how much fatigue such lifting (15–18 pounds) induces and how great is the danger to the expectant mother, especially during the last half of her pregnancy." In the spooler room the physical strain resembles that of the weave room. There is a great excess of deaths of married women over those of single women, due almost entirely to parturition fatalities. The deaths among married operatives exceed those of married non-operatives from non-tuberculous causes.

The number of deaths among married women operatives in each room was shown

TABLE 4. — PERCENTAGE BY WHICH DEATH RATES OF FEMALE WEAVERS EXCEEDED (+) OR FELL BELOW (−) RATES FOR FEMALE NON-OPERATIVES

Conjugal State	Cause of Death	
	Tuberculous	Non-Tuberculous
Single	− 5	+ 7
Married	+226	+160

to be markedly higher than that of either single women operatives or married non-operatives. The deaths from parturition causes followed this general trend without exception. Further figures for the cotton industry as a whole show that many deaths which were classified as "Tuberculous" were "Parturition Complicated." (See Table 5.) The character of the work, as it is described, can without doubt be held responsible for this high mortality. Figures for the industry as a whole showing the deaths from parturition for operatives and

TABLE 5. — TUBERCULOUS DEATHS AND DEATH RATES PER 1,000 AMONG MARRIED FEMALES (15–44 YEARS) BY CAUSE AND OCCUPATIONAL GROUP

Occupational Group	Number of Deaths				Death Rate per 1,000		
	Not Parturition Complicated	Parturition Complicated		Total	Not Parturition Complicated	Parturition Complicated	Total
		Number	Per Cent.				
Operatives	88	37	30	125	3.56	2.0	5.56
Non-operatives	77	19	20	96	1.06	0.36	1.42

non-operatives bear out this conclusion. Between the ages of 15 and 24 the death hazard complicated with parturition is seven times as great for operatives as for non-operatives; between the ages of 25 and 34, the death hazard is three times as great; and between the ages of 35 and 44, the death

hazard is equal. The conclusion of the whole report is that "employment in cotton mills for mothers of child-bearing age is generally inimical to longevity of mothers."

It must be remembered that this report contemplates only the *deaths* in the cotton industry. How many women and how many children have been definitely harmed but not killed by the employment of women during pregnancy was not investigated. This survey should stimulate additional inquiries into the cotton industry and into every other industry employing women, with a view to bringing to light similar race hazards.

The general conditions in industry, which we have discussed, do not constitute the only hazards to the pregnant woman. There are many industries which utilize substances which in themselves are harmful. These substances are commonly classed as harmful to women in general and are, therefore, more especially injurious to the pregnant woman. On this account, many of the following occupations are prohibited to women (10) both in this country and in certain foreign countries: (1) the making of electric accumulators; (2) manufacture of paints, varnishes, and colors; (3) brass casting, zinc and lead smelting; (4) certain processes of glass manufacturing; (5) the manufacture of high explosives (previous to the war); (6) the curing and tanning of skins and hides. In France, lace bleaching with white lead, sharpening or polishing of metals, and coating mirrors with quicksilver are among the many occupations prohibited. All the countries prohibit the employment of women in any lead industry. The majority of occupations forbidden to women involve the presence of dust, fumes, vapors, gases or substances of a poisonous character. There are many more industries which could properly be included in this list, especially when they are considered specifically with regard to the pregnant woman; *i. e.*, such industries as the manufacture of cordage and twine, enameling, the rubber industry, and pearl button manufacture.

In a series of articles, Dr. Alice Hamilton (11) has described the occupational effects of many chemicals used in industry. There are many which are especially harmful to the pregnant woman, such as benzene, used principally in the manufacture of rubber, in paint and varnish removers, in making aniline dyes; nitrobenzene, used in cleaning establishments; aniline, employed in the manufacture of dyes, rubber, and black paints, and in printing trades, etc.; arsenic, used in a large number of industries, such as in the manufacture of insecticides. Any substance affecting the kidneys is particularly dangerous for the pregnant woman because of the already overburdened renal functions at this time. The poisoning which results from the use of mercury, in processes such as silvering of mirrors, making of incandescent lamps, and felt hat manufacture, is especially prone to affect the pregnant woman. Carbon monoxide poisoning, which is one of the most commonly encountered industrial intoxications, is a hazard in many laundries, in tailoring trades and in bakeries, where gas burners are used. When this gas is inhaled in only moderately large quantities it has distinctly deleterious effects both on the normal and the gravid woman.

The lead industry seems to be the most hazardous industry for the pregnant woman. Lead poisoning takes many forms, for women its most disastrous effect being on the generative organs. In her report on *Women in the Lead Industries* (12), Dr. Alice Hamilton states that "women who suffer from lead poisoning are more likely to be sterile or to have miscarriages and stillbirths than are women not exposed to lead. If they bear living children, these are more likely to die during the first year of life than are the children of women who have never been exposed to lead. This

means that lead is a race poison." Dr. Hamilton cites the following statistics from the report of the British factory inspector for 1897 as striking proof of this fact: Out of 62 women who were pregnant, 15 never bore a living child. There were 212 pregnancies among these 62 women, but only 61 living children resulted; the stillbirths numbered 21; the miscarriages, 90. There are many available proofs of the danger to pregnant women from employment in occupations that bring them in contact with lead, and many obscure instances of lead poisoning in addition to the well-known cases. For instance, commercial artists or retouchers use a great deal of white lead, thinking that it is zinc. Lithotransfer work consists of preparing transfer papers with lead colors. There are many more such industries where lead poisoning is common, though seldom recognized.

Summary

1. The pregnant woman is better off in the normal home environment than at work in a factory.

2. With proper supervision, however, it will not be harmful for the normal pregnant woman to work, if work is an economic necessity for her.

3. All pregnant working women should receive careful medical and vocational supervision.

4. The abnormal pregnant woman should discontinue work, and should resume it only on the advice of a competent physician.

5. The pregnant woman is an increased accident risk for the manufacturer. By means of careful supervision, however, this risk may be reduced to a minimum.

6. Any occupation that is harmful to the general woman worker is of greater harm to the pregnant worker.

7. The following types of occupations are harmful: (*a*) continuous sitting; (*b*) continuous standing; (*c*) repeated lifting, reaching, stretching; (*d*) jolting; (*e*) any work requiring new muscle adaptations.

8. Certain specific occupations are distinctly harmful to pregnancy and to childbearing functions. Lead trades constitute the outstanding example of this group.

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A METHOD FOR DETERMINING THE FINER DUST PARTICLES IN AIR*

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IT is well known that a suspension may be removed from air by bringing the air in contact with water. The more intimate and prolonged the contact, the more efficient will be the removal. One of the simplest means of effecting such an intimate mixture, for purposes of dust analysis, is to introduce a small volume of air into a syringe containing some water. The syringe may then be shaken vigorously and a very thorough mixture of air and water accomplished. If a drop of the water be examined with the microscope by ordinary illumination, very few particles, if any, will be seen; by oblique illumination, however, the minute matter scintillates in the field and may readily be counted. This constitutes, in brief, the principles of the method presented in this paper, a method that is concerned chiefly with the minute particles.

In E. V. Hill's method (1) the air is drawn through the narrow nozzle of a capsule attached to a metal syringe; whereupon some of the particles impinge upon a small glass slip covered with a thin layer of a transparent adhesive mixture. A variable percentage of particles is actually caught, owing partly to the fact that the particles differ in inertia. The greater the inertia, the greater the likelihood of their being directed against the adhesive surface. Because of this property of inertia, the rate with which the piston of the syringe is withdrawn will influence the result. The count is made with ordinary illumination.

Palmer's method (2) consists in the filtration of air by means of the water-spray; but here again the removal is far from complete. Katz, Longfellow, and Fieldner (3) find that the Palmer apparatus retains about 45 per cent. by weight of air-floated silica and 13 per cent. of tobacco smoke as measured by the Tyndall effect. The air passing at the rate of 4 cubic feet per minute is in contact with the water but a very short time.

Aitken devised a method for the estimation of atmospheric dust (4) based on the principle that the dust particles serve as nuclei for the condensation of water-vapor. In this case all particles, even the minutest or those of an ionic nature, are included in the precipitation and share in the count. The watery envelope makes any determination of size difficult. The coalescence and evaporation of droplets may easily give rise to erroneous counts. It is a method requiring extraordinary care and skill.

Bill's electric precipitation method (5) is in process of development. The removal of dust particles appeared to be greater than in Palmer's method but in its present form it is unsuitable for field work. In this method, as in Aitken's, all particles of whatever size tend to undergo precipitation. The determination is gravimetric.

PROCEDURE

A Luer syringe graduated to 100 c. c. but having a capacity of about 160 c. c. is thoroughly cleaned with soap and water and alcohol to remove all grease. It is then rinsed with freshly distilled water and filled with distilled water free from air bubbles. After forcing out all the water, 20 c. c. of distilled water are taken into the syringe from an Erlenmeyer flask provided with a cotton-wool filter (Figure 1). The syringe is now ready for the air sample. The piston is withdrawn sufficiently to admit approximately 100 c. c. The exact volume may be read from the graduation. While placing the finger tightly against the nozzle, a piece of rubber membrane intervening, the syringe is shaken vigorously for one minute with an up and down motion. With the syringe in a vertical position the water is brought up to the very tip of the nozzle and then withdrawn slightly to

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admit a small bubble of air. This manipulation is intended to catch the particles adherent in the narrow portion of the nozzle and bring them into suspension.

The next step consists in allowing a drop to flow from the syringe into the chamber

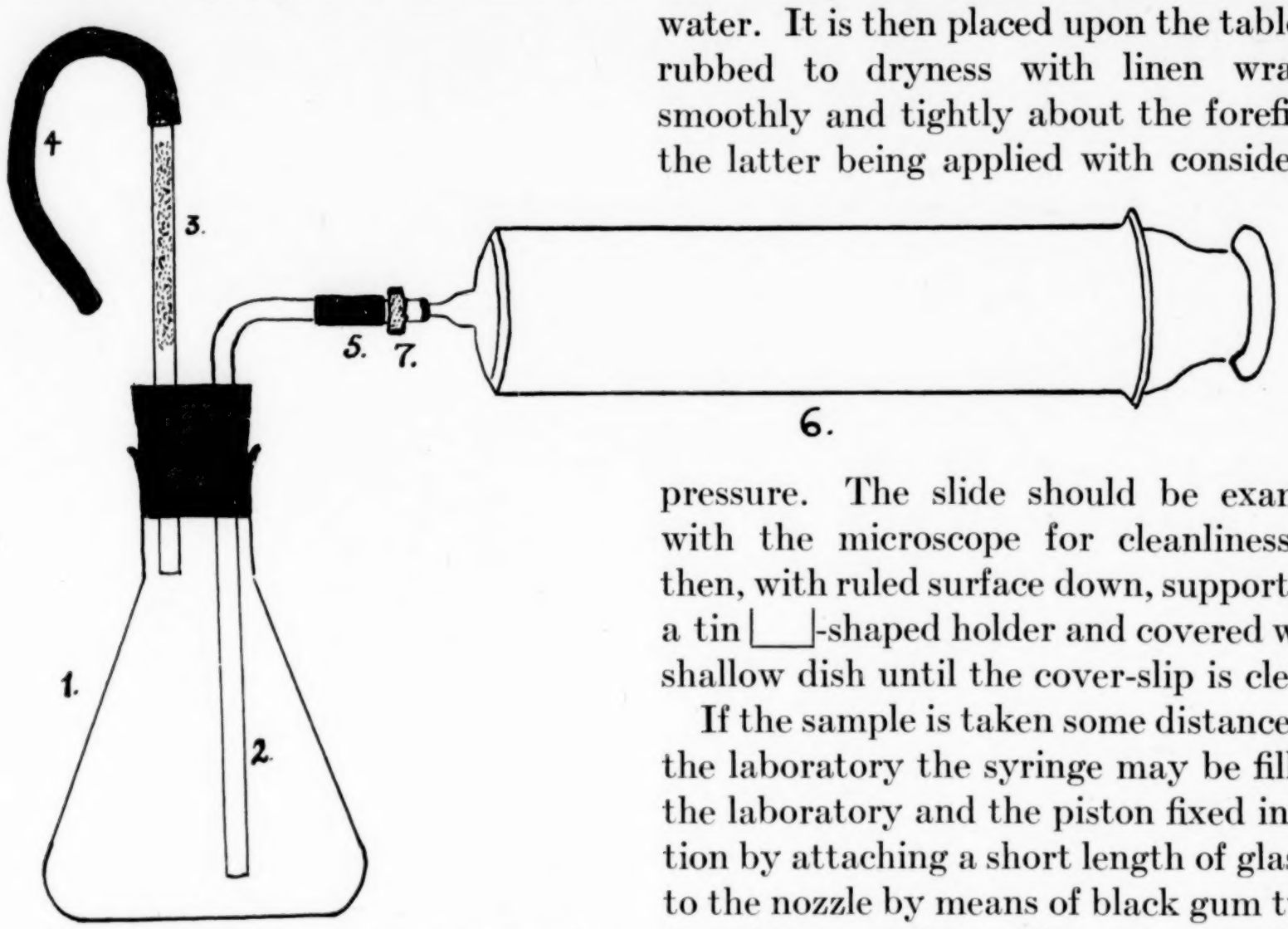

FIG. 1. — 1. Erlenmeyer flask. 2. Glass tube. 3. Glas[s] tube containing cotton-wool. 4. Rubber tubing. 5. Pure gum connecting piece. 6. Luer syringe. 7. Metallic connecting piece.

of a Levy blood counter. This is best done with the metal connecting piece on the nozzle. The particles are counted by oblique illumination. The results reported in this paper were obtained with the No. 3 objective of a Leitz microscope with a circular piece of blue glass below the Abbe condenser. A 75-watt Mazda daylight lamp was placed in front of the mirror, a jar of water intervening to absorb the heat rays. Both lamp and jar were covered with an asbestos hood.

It will require patient practice in the beginning to free the ruled surface and cover of the Levy chamber of dust particles. A surface sufficiently clean for ordinary illumination will not do at all for oblique illumination. It is well to have on hand several handkerchiefs of pure linen that have been washed several times. Lens paper is useless. The ruled surface is thoroughly rubbed with the thumb, under a tap of warm water, and finally rinsed for a moment in hot water. It is then placed upon the table and rubbed to dryness with linen wrapped smoothly and tightly about the forefinger, the latter being applied with considerable pressure. The slide should be examined with the microscope for cleanliness and then, with ruled surface down, supported on a tin ⌊⌋-shaped holder and covered with a shallow dish until the cover-slip is cleaned.

If the sample is taken some distance from the laboratory the syringe may be filled in the laboratory and the piston fixed in position by attaching a short length of glass rod to the nozzle by means of black gum tubing free from powder. After the sample has been taken, it remains in the syringe with the piston fixed. This permits another thorough mixture on reaching the laboratory. The entire number of particles in two fields, each a square millimeter, are counted. The average of these two counts is used in the calculation. Those fields are selected which are divided into sixteen smaller areas, each a sixteenth of a square millimeter. The particles must be allowed to settle before the count is made.

A Modification of the Foregoing Procedure

A few determinations have been made with a modification of the above method, somewhat more complicated, but based on exactly the same principle. In this paper the steps will be merely indicated.

A test tube of 150 c. c. capacity, provided with a glass stopper perforated by two glass tubes, one of which extends to the bottom, is filled with distilled water. A filter (Figure 2) is connected with the short tube. The syringe being attached to the long

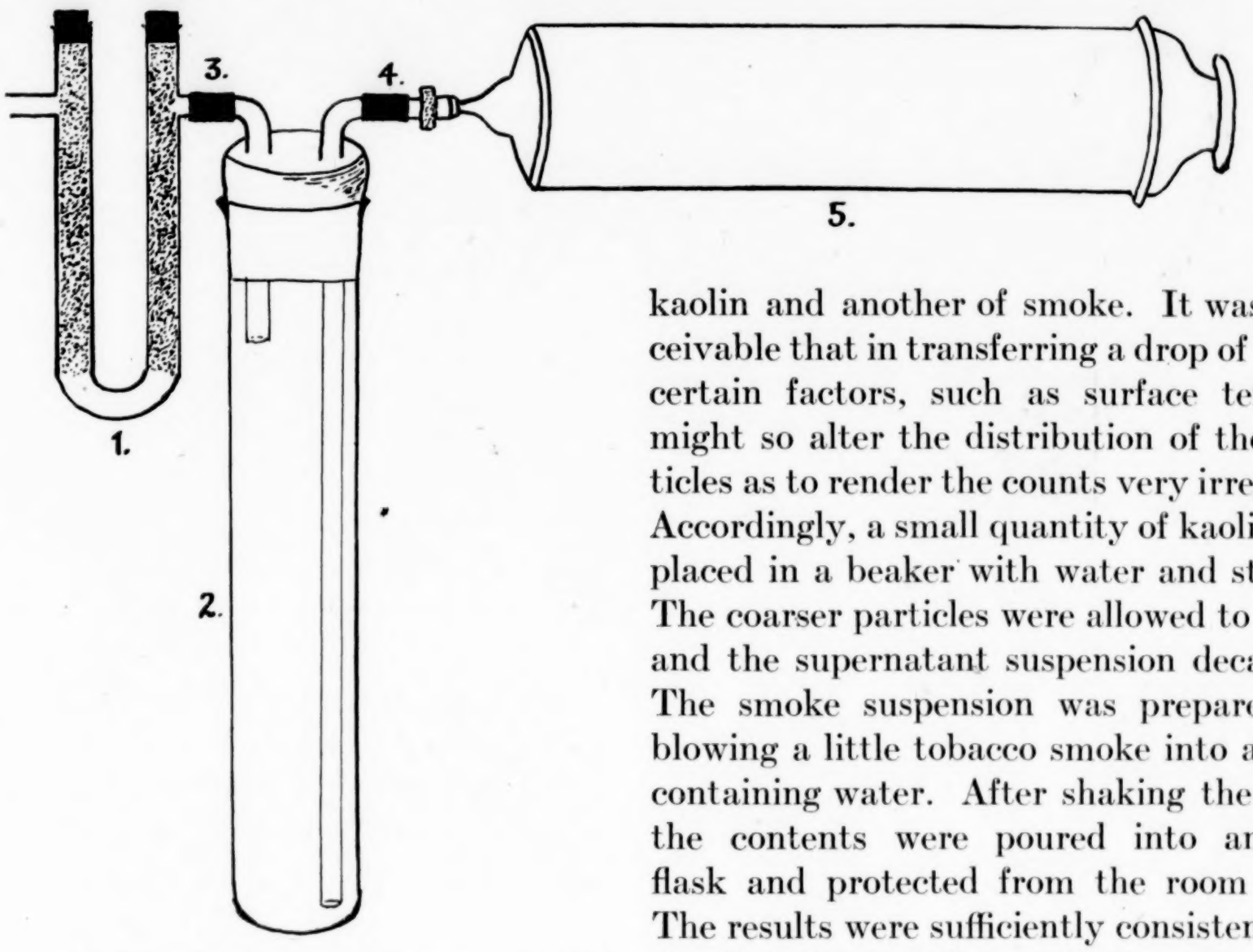

FIG. 2. — 1. Filter containing cotton-wool. 2. Test tube provided with glass stopper perforated by two glass tubes. 3 and 4. Pure gum connecting pieces. 5. Luer syringe.

tube, the contents of the test tube are emptied to the 30 c. c. mark. The test tube now contains filtered air and 30 c. c. of distilled water. An air sample may be taken by removing the filter and connecting the short tube with the syringe. After vigorously shaking the test tube, the syringe is again connected with the long tube for the purpose of bringing into suspension all particles adherent in the long tube. This is done by moving the piston back and forth a short distance. Finally, a portion of the water is allowed to remain in the syringe so that a drop may be transferred to the counting chamber.

RESULTS

Before proceeding with the actual determination of particles present in air, it appeared desirable to test the consistency of the method with a prepared suspension of kaolin and another of smoke. It was conceivable that in transferring a drop of water certain factors, such as surface tension, might so alter the distribution of the particles as to render the counts very irregular. Accordingly, a small quantity of kaolin was placed in a beaker with water and stirred. The coarser particles were allowed to settle and the supernatant suspension decanted. The smoke suspension was prepared by blowing a little tobacco smoke into a flask containing water. After shaking the flask, the contents were poured into another flask and protected from the room dust. The results were sufficiently consistent and clearly indicated that no factors operate to introduce serious irregularity in this part of the procedure.

Counts made with distilled water alone — not prepared with unusual care — showed an average number of particles per square millimeter of 12 ± 2. This figure is used as a correction in calculating the number of particles per unit volume of air. The distilled water is not entirely responsible for this count; some particles unavoidably remain on the ruled surface during the cleaning process.

The results of the determinations of the dust content of outdoor air and laboratory air appear in Table 1. The outdoor samples were obtained in a street comparatively free of traffic; those of indoor air were taken in one of the rooms of the laboratory

TABLE 1. — DUST PARTICLES IN THE AIR

Date	Source of Sample	Number of Sample	Size of Sample (c.c.)	Time	Count per Sq. Mm.		Difference	Average Count per Sq. Mm.	Particles per c.c. of Air
					1st Field	2d Field			
October 30.....	outdoors	1	103	10:30	34	28	6	31	36,800
		2	202	11:10	40	50	10	45	32,600
November 1.....	"	1	202	1:30	31	29	2	30	17,800
		2	306	2:05	38	50	12	44	20,900
		3	405	3:50	53	60	7	57	22,200
November 3.....	"	1	205	9:45	55	54	1	55	41,900
		2	207	11:00	52	51	1	52	38,600
November 4.....	"	1	102	10:30	33	38	5	36	47,000
		2	202	11:40	59	53	6	56	43,500
		3	205	4:40	50	53	3	52	39,000
November 5.....	"	1	205	1:42	43	53	10	48	35,000
		2	302	2:50	58	56	2	57	29,500
November 8.....	"	1	306	10:30	64	68	4	66	35,200
		2	203	11:50	43	44	1	44	31,500
		3	101	1:25	27	30	3	29	33,600
		4	205	2:40	39	51	12	45	32,100
		5	100	3:50	31	31	0	31	38,000
		6	102	4:30	25	32	7	29	33,300
January 5.....	"	1	102	9:35	47	63	19	57	88,200
		2	202	9:42	92	103	11	98	85,100
		3	207	9:47	96	101	5	98	82,600
October 28.....	laboratory	1	105	10:45	41	39	2	40	53,300
		2	102	11:30	38	35	3	37	49,000
		3	102	1:00	34	36	2	35	45,000
November 9.....	"	1	204	10:30	67	70	3	69	55,800
		2	202	11:09	73	67	6	70	57,400
		3	202	1:15	68	62	6	65	52,400
		4	202	2:20	60	60	0	60	47,500
		5	204	3:00	71	53	18	62	50,000
		6	202	3:50	64	65	1	65	52,400
November 10.....	"	1	205	10:05	53	43	10	48	35,100
		2	206	1:00	56	52	4	54	40,700
December 28.....	"	1	206	1:00	62	70	8	66	52,400
		2	206	2:20	61	51	10	56	42,700
		3	205	3:35	67	54	13	61	47,800
December 31.....	"	1	102	10:45	37	49	12	43	60,700
		2	102	11:15	45	31	14	38	50,900
January 4.....	closed cabinet	1	102	1:10	31	34	3	33	41,100
		2	101	2:05	33	35	2	34	43,500

in which there was generally but one occupant. If the dust content of the air were absolutely constant, our method would not permit us to expect a better agreement than the figures in the table actually show. With one or two exceptions, the average deviation of the number of dust particles per cubic centimeter of air is not more than ±4,000 for 100 c.c. samples, nor more than ±2,000 for 200 c. c. samples. The derivation of these figures will readily be understood upon recalling that the average count for distilled water is 12 ±2. Owing to the small number of samples in most of the series, there is no significance in the fact that in one or two instances the above limits are slightly exceeded.

The results in the table, therefore, mean

that the amount of dust present in the air on any single day was, in general, practically constant under the conditions that prevailed when the samples were taken. When one bears in mind the errors incident to enumeration and the possibility of certain influences disturbing the dust content of the air, the agreement is remarkable. There is a variation from day to day and the figures for indoor air are on the whole higher than those for outdoor air, although they are not strictly comparable, having been obtained on different days. On the morning of January 5, the atmosphere was unusually smoky and the counts are correspondingly high. The samples of air from a closed cabinet free from disturbing influences are practically identical in their dust content.

Discussion

Before the method was actually tested, it seemed doubtful whether one could hope for consistent results, partly because of the possibility of the inclusion of particles between the barrel and piston of the syringe and partly because of the exposure of the piston to the dust particles of the air. But experience showed that it makes no difference whether samples of 100,, 200, or 300 c. c. are taken; in other words, whether the piston is withdrawn once, twice, or three times. These factors, then, if they operate, do not endanger the usefulness of the method. In the modified form of the method any error from this source would disappear.

One minute's shaking is sufficient to bring the particles into aqueous suspension. A more prolonged shaking does not increase the count. This is exactly what one would anticipate from the work of Katz, Longfellow, and Fieldner (3) who find that Palmer's apparatus in which the air is in contact with the water for a very brief interval retains 13 per cent. of smoke.

The same objection applies to this method as applies to all methods in which water is used as a medium. Water-soluble particles will not be included in the count. In many cases, however, particles lost in solution may be determined by chemical methods. Bill (5) points out that the particulate matter in the Palmer suspensions shows a tendency to form small masses or clumps. The minute particles in my own suspensions have not shown any agglomeration. Counts made of suspensions that were allowed to stand for nearly two hours were practically as high as those made in the beginning.

In routine work, such as the examination of air in factories, where several samples taken at short intervals are desired, the contents of the syringe may be emptied into small 25 c.c. Erlenmeyer flasks and covered with rubber membrane secured by an elastic band. In the modified form of the method, a series of test tubes each provided with a glass stopper perforated by two glass tubes (Figure 2) may be employed.

Conclusion

1. A method has been presented in the foregoing pages, based on the enumeration, by oblique illumination, of minute particles in a sample of air brought into aqueous suspension by shaking the sample with water.

2. Success in the use of the method demands strict attention to cleanliness.

3. The method requires but a very small sample of air and yields consistent results.

4. The method ought to be especially suitable for the determination of smoke particles and should also prove useful in determining the efficiency of air-filtering devices in ventilation systems.

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ANILINE POISONING IN THE RUBBER INDUSTRY*

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ANILINE ($C_6H_5NH_2$), a primary amide of benzol, is a colorless, volatile oil which, when exposed to air and light, is very unstable, and rapidly changes in color to dark brown and even to black, leaving a residue. It can be produced in several ways but the most common commercial method is by the action of hydrochloric acid and iron filings on pure nitrobenzol ($C_6H_5NO_2$). It is used principally in the manufacture of aniline dyes, photographic materials, rubber compounds, and shoe polishes.

The aniline of commerce is contaminated by very small to large amounts of nitrobenzol, dimethylaniline, and its nitroso bodies, all of which have a predilection for action on the blood and nervous system, similar to all homologous derivatives of benzol. Von Jaksch (1) claims that, as far as records show, pure aniline does not produce poisoning, but that it is the mixture of amidobenzene, meta-toluidine, para-toluidine and ortho-toluidine and xylidine which is poisonous. It is the experience of Dr. Alice Hamilton (2), however, that "chemically pure aniline produces all the symptoms and blood changes characteristic of industrial anilism." The experiments of K. B. Lehmann show that pure aniline is very toxic in even smaller quantities than carbon disulphide, toxic symptoms following the inhalation of 0.1 to 0.25 gm. of aniline, while it takes from 1 to 1.1 gm. of carbon disulphide to produce symptoms of poisoning.

Methods of Absorption

The poison may enter the body through the skin, the respiratory tract, the alimentary tract, and through a combination of these three ways. Aniline oil is readily absorbed by the skin, and in a very short time produces marked symptoms. One case is recorded in which death resulted from poisoning due to absorption through the skin of the feet from a pair of shoes which had been colored with aniline dye and had been put on before the dye was dry. A large proportion of the cases which I have seen have developed their symptoms from skin absorption.

Respiratory absorption is also very common. Individuals working in aniline or any of its derivatives in rooms where the ventilation is poor and the aniline bodies are subject to heat develop typical aniline symptoms after varying periods of time, depending on the concentration of the gaseous substance. Absorption through the alimentary system is the smallest factor in producing symptoms of aniline poisoning and one which can be controlled largely by education and instruction concerning the necessity for cleanliness during eating and drinking. The most serious results and the most acute symptoms are produced by a combination of all three methods of absorption.

Clinical Picture

Symptoms. — The characteristic symptoms of aniline poisoning in the order of their appearance as observed in many cases are: slight insomnia or drowsy feeling; neurovascular symptoms, such as flushed face, weariness and mental uncertainty in extreme cases, and sometimes an irritable disposition; headache, dizziness and nausea; beginning cyanosis, chilliness and a sensation of cold; pulse, rapid and weak, gradually becoming slower with de-

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creased blood pressure; loss of appetite, indigestion; irregular respiration; dryness and choking sensation in the throat, burning and stinging sensation of the eyelids; joint pains, muscle pains; spots before the eyes; hematuria in rare cases; painful urination in extreme cases, and hyperacidity; constipation or diarrhea; skin eruptions, macular in rare cases; difficulty in talking, accompanied by loss of memory; very deep cyanosis followed by unconsciousness; and in rare cases, hemoptysis. Each patient does not, of course, present all symptoms, but he may have had them at some time. The marked pallor of the skin, cyanosis of the lips, and a history of work in aniline, together with a characteristic odor of aniline which is usually present, should remove any doubt about the diagnosis.

There is a class of men who work in aniline who seem to acquire a tolerance for the substance, in that they remain cyanotic for years without the development of any apparent, serious symptoms. Through a change of work, however, such mild symptoms as do appear clear up, the blood and urine return to normal, and we diagnose the cases as chronic. These patients have some blood changes, of course, yet they feel no ill effects except for a slight tired feeling at the end of a day's work. The body attempts to maintain an equilibrium between intake and output of aniline, but there is a surplus amount which is absorbed and which causes blood changes that are responsible for the marked cyanotic condition.

Laboratory Findings. — The blood changes consist principally in the formation of methemoglobin and a coincident decrease in hemoglobin, with resulting deficient oxygen supply to the tissues. There is also a decrease in the number of red blood cells, with anisocytosis and poikilocytosis, and in very acute cases there may be a slight leukocytosis and basophilic degeneration of the red cells. After the removal of the patient from contact with aniline or its derivatives, the leukocyte count returns to normal and in some cases even a slight leukopenia is found. There frequently occurs a diminution of polymorphonuclears with a corresponding increase in small lymphocytes, and a slight eosinophilia.

In very severe cases of poisoning, some embryonic forms of red cells appear, the hemoglobin (Sahli's method) is decreased, and there is considerable formation of blood dust. Tallqvist's scale cannot be used with any success, for as soon as the methemoglobin is exposed, the color is changed. In the advanced cases, the coagulability and the viscosity of the blood are diminished.

After examining over 100 urines from cases ranging from those with marked beginning symptoms to those with persistent symptoms, I am of the opinion that no definite rule for urinary findings can be formulated, except that in the most severe cases, if large quantities of urine are tested, there can be found traces of hematin, presumably due to blood cell destruction. The following is a summary of the urinary findings from the cases which I have examined: specific gravity, 1.005 to 1.030; reaction, usually acid, a large amount of uric acid being present; albumin, negative, except in cases where extreme anemia had resulted; sugar, negative; aniline or aniline radicals, negative; phenol, negative; acetone, negative; diacetic acid, negative, except in severe cases. Nearly all cases showed traces of hematin when twenty-four-hour specimens were evaporated.

Microscopic examination generally revealed large quantities of uric acid crystals, urates, and oxalates. One case showed marked kidney involvement. It could not, however, be proved that this was caused by aniline, as this man's condition before he went to work in aniline was not known. In one case the urine was cloudy and, on mi-

croscopical examination, no formed elements were found, but large quantities of fat globules were present. In another case, diacetic acid was found, but no trace of sugar; while in still another, there was present diacetic acid with a slight trace of sugar. Two cases showed bladder involvement which improved under change of work and treatment.

Complications. — In severe cases especially, there may appear certain complications such as secondary anemia, which it is difficult to clear up; an irritative cystitis; and inhibition of the red-cell forming organs — a condition which gradually returns to normal when the patient is removed from contact with aniline. In alcoholics a predisposition to glomerular nephritis is often noted.

Several cases of gastric involvement, especially gastric ulcers, have been reported by German authors, but I have never seen a case of gastric ulcer develop, in which aniline was the cause. I know of one instance in which a worker with gastric ulcer claimed that it was due to aniline, but investigation proved that he had been exposed to very little aniline and only for a period of a few minutes. Sometimes eczematous skin rashes appear, particularly on the covered parts, the scrotum, the arm pits, and inguinal regions, and occasionally we see a pustular eruption resembling a furunculosis. Examination of the pus from one of these furuncles shows staphylococci and streptococci.

Prevention

The most important factors in the prevention of aniline poisoning are: (*a*) education and instruction of employees working in aniline; (*b*) proper ventilation (forced); (*c*) handling of aniline compounds in closed receptacles; (*d*) restricted length of time for working in the fumes of aniline; (*e*) better personal hygiene; (*f*) an immediate bath if aniline or any of its derivatives are spilled on the clothing or the skin; (*g*) protection of the hands by rubber gloves, and of the feet by wooden shoes, rubber boots, or rubber-soled shoes in production plants where the floors are wet with aniline.

Some employers furnish milk for their employees to drink, but I see no advantage in this; in fact, rather the opposite, for milk is constipating and thus blocks one of the channels of excretion. One large manufacturing company gives its aniline workers a teaspoonful of vinegar (acetic acid) before they go to work, with the idea of producing soluble aniline compounds which may be excreted by the kidneys. Personally, I have obtained very good results from the use of lemonade containing Epsom salts. It furnishes the average worker with enough citric acid and salts in a day to increase catharsis and diuresis. The following is the formula which I have used:

Oranges	½ to 1 dozen
Lemons	2 to 2½ dozen
Water	8 gallons
Saturated solution Epsom salts	16 ounces

Sugar to taste.
Serve cold.

It is advisable that all persons working in aniline should be examined at frequent intervals and a record of the examination made. The form illustrated in Figure 1 has been found to be very convenient for this purpose. The foreman who has charge of aniline workers should be instructed concerning the hazards of the work and should report any men who show symptoms of poisoning. All aniline workers should have short periods to work and longer ones to spend in the open air. They should abstain from alcohol as it seems to predispose to aniline absorption, particularly in young men.

Treatment

Preventive treatment is, of course, the best to pursue. When poisoning has al-

FIGURE 1

SPECIAL EXAMINATION FOR ANILINE WORKERS

Age Nationality M.S.W. Date

How long have you worked here? How long in the department?

Have you felt perfectly well during the past year? Past six months?

Have you ever had, or have you now any of the following:

Muscle weakness, twitching of muscles, or muscle pains
Large amounts of saliva
Exhausted or "tired out" feeling
Fast or slow breathing
Drowsy or sleepy feeling
Rapid heart
Chilliness or cold feeling
Nasal trouble, catarrh, discharge into back of throat from nose
Indigestion Constipation Diarrhea Vomiting Nausea
Nervousness Irritability Headache
Joint pains
Unconsciousness Dizziness Loss of memory
Difficulty in talking
Spots before eyes
Spitting of blood
Cold hands or feet
Dryness or choking sensation in throat
Burning or stinging sensation of eyelids
Painful urination
Skin eruption Duration
Loss in weight in the last six months

Physical Examination

General appearance

Face and head		Eye reflexes		
Thorax	Lungs	Heart	Pulse	Blood pressure
Abdomen	Liver	Spleen	Stomach	
Genitalia				
Reflexes	Knee jerk	Babinski	Romberg	
Extremities				
Skin	Areas of anesthesia or hyperesthesia			
Blood: Hemoglobin	White cells	Red cells	Pathological cells	
Urine: Specific gravity	Albumin	Sugar	Reaction	

Remarks:

Examining Physician

ready occurred, however, the patient must be treated for oxygen lack and acidosis. Very mild cases need free elimination and open air, while the more severe ones require artificial respiration, injections of heart stimulants, and blood transfusion.

In acute cases the first step is to remove the patient to the open air, loosen his clothing and examine it as a possible source of absorption. If it is found to be saturated with aniline fumes, it should be taken off at once. Give oxygen inhalation, if necessary, remove the excess of aniline from the surface of the skin with soap and water, and with a vinegar bath dissolve the aniline from the pores of the skin. Use heart stimulants, such as caffein, camphorated oil, or ether, but no tinctures because of the alcohol which they contain and which should be abstained from. An enema of soap suds and glucose (2 to 3 ounces) may be given. If the patient is conscious, give him 1 ounce of glucose in water, alkalinized with sodium bicarbonate. Blood letting, transfusion, or possibly infusion of normal saline may be necessary. Lavage of the stomach has been resorted to, but seems to be more hazardous than beneficial. It is important to promote the excretion of the poison by free diuresis, catharsis and sweating. The various symptoms should be treated as they appear.

Summary

Aniline and its immediate homologues are blood and nervous system poisons which produce their effects by internal suffocation. They cause destruction and hemolysis of the red blood cells and marked production of methemoglobin, and, in severe cases, acidosis. In acute cases, a slight basophilic degeneration of the red cells also takes place. Very little effect is produced on the white blood cells, the only change being a transitory leukocytosis in the beginning of acute cases.

There are very few complications except in severe cases.

Alcohol seems to be a predisposing factor for early symptoms.

Preventive measures should be instituted in preference to after-treatment.

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OIL FOLLICULITIS *

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THE marked increase in our industrial population makes a study of the occupational affections of the skin of special importance. These affections will tend to increase as greater numbers of persons are drawn into the industries, as new industries are developed, and as new products are introduced. This paper is concerned with skin affections due to oils, and particularly with those due to the use of machine oils, an investigation of which was undertaken to determine the cause of an outbreak of furunculosis among the employees of a machine shop.

Affections of the skin due to petroleum and its products have long been recognized, various terms being used to designate them. By some authors they are considered as belonging to the eczemas, and by others as dermatites or dermatoses. There is, indeed, a considerable amount of confusion as to the correct terms to be used for all the various skin diseases, and those due to occupations are not exceptions. R. P. White (1), in discussing the question of terminology, says "It would seem that, as a term intended to express a whole group of these disorders, the word 'eczema' is both incorrect and inadequate. It would, therefore, seem more convenient and logical to use the non-committal term 'dermatitis.' This will embrace all so-called trade eczemas, as well as other forms of skin disease caused by employment, and where possible the name of the offending agent should be prefixed to it." Following White's suggestion, we might designate skin affections due to oils as *oil dermatites*. This does not, however, clarify the matter to any extent, since the different oils produce different affections. In the case of machine oil, the trouble seems to be largely a mechanical plugging, followed by inflammation and infection of the follicles. For this reason we suggest the name *oil folliculitis*.

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Historical Review

An exhaustive study of skin affections due to occupations has been made by Knowles (2). In the course of his discussion, this author says "fully one-quarter of all cases of eczema are of definite external origin. Almost one-sixth of all cases of this affection is caused by the occupation of the individual. . . . The largest number of cases of the so-called occupation eczemas are seen in the workers in the household and next most frequently in laborers. Practically every occupation and every irritant may produce an eczema." Knowles' paper reports forty-five cases of eczema in individuals who handled oils, greases, carbon, graphite, etc. Oppenheim (3) in Germany examined 1,800 operatives who presented themselves in his practice, and found that 400 of the cases, or 22.2 per cent., were due to the employment of the patients.

The earlier works upon the harmful effects of petroleum and its products upon the body were confined largely to the poisonous or intoxicating action when these substances were taken internally. Lewin (4) in an article written in 1888 gives an ex-

tensive bibliography of the earlier literature on this subject, and also reports results obtained by feeding oils to animals. He refers to two early descriptions of skin affections due to petroleum, the first (5), designated as "eczematous," the second (6), described as consisting of small ulcers with erysipelatous red bases, or as consisting of blisters with red but not indurated bases. After the latter type of ulcer had once been healed, it did not develop again, even though the patient continued in contact with the product.

J. C. White (7), on the other hand, states that he has recommended petroleum for many years for the destruction of scalp and pubic lice, and has never seen the slightest indication of irritation from its use. He also states that he has seen teamsters wash their faces and hands in the oil without ill effects. In conference with the superintendent of a large refinery, Dr. White found that there was very little skin trouble among the workmen and that whatever irritation there was appeared mostly in hot weather, and only among a few of the workmen handling paraffin products. The lesion in these cases consisted of a mild degree of eczematous inflammation on the backs of the hands and forearms, which disappeared rapidly after the occupation was given up.

Lewin (4) discusses at some length an outbreak of pimples, boils, acnė, and black comedones on the hands, arms, and other parts of the body in a group of workmen in the petroleum industry. This affection continued for different lengths of time and with varying severity in different individuals, in some instances continuing as long as the men were employed in the work. It appeared to Lewin that the inflammation went hand in hand with the stopping of the hair follicles and sebaceous glands. After these were closed, there was a continuation of glandular secretion, but excretion being inhibited, the condition was gradually exaggerated and soon involved all layers of the skin. The longer the process continued, the more intense the inflammation became, finally spreading to neighboring glands and hair follicles, or to the subcutaneous tissue. In the course of his study, Lewin found that the heavier petroleum products, particularly those which distill at 250°–360° C., possessed the most marked property of causing inflammation. He tested the action of these products by feeding them to animals, and considered that the action upon the stomach wall was similar to that on the skin. He also noted that the individuals of most cleanly personal habits suffered least from this trouble. Similar skin affections have also been described by Ogston (8) as due to the paraffin products from cannel coal and various other raw petroleum products.

A folliculitis and perifolliculitis of spinners called *bouton d'huile* was first described by Purdon in Belfast in 1867, and by Leloir (9) in Belgium in 1889. This affection was due to the irritating action of the oil used on the machines. In England sperm oil was the most common lubricating agent; in Belgium, on the contrary, mineral oil was largely used. The oils from Russia were usually unmixed, as were those from America, while the shale oil from Scotland was usually mixed with olive or colza oil in the proportion of ten to fifty parts per hundred. Purdon (10) in his article discusses an acneform eruption of "doffers" (usually young girls who remove the bobbins and clean and oil them) in flax spinning mills. The affection is evidently a folliculitis due to the sluggish action of the sebaceous glands, the orifices of which are choked by the oil and irritated by the flax water that comes off the bobbins. The eruption, which occurs usually in persons under 20 years of age, of either sex, but chiefly in girls who expose their arms by wearing short sleeves, may be described as follows: The acne eruption commences with a small, dull red papule, shotty to the touch, occurring on the forearms and

wrists, and when a little matured has a small black speck in the center of the papule, like a comedo, showing the plugged sebaceous follicle. Next, the papule increases in size, finally suppuration occurs, and the papule disappears.

In Belfast, Purdon did not find eczematous conditions of the hands such as those described by Leloir in Belgium. In describing the trouble, Leloir says that it is seated in the hair follicles; these become dilated and filled with broken hairs and horny cells mixed with dirt and oil, thus setting up a perifolliculitis. The corium around the follicle becomes infiltrated with round cells, the vessels dilate, and some of the tissues necrose. Eventually the whole follicle may be discharged.

Lefebvre (11), writing in 1888, states that skin lesions of the nature described above are of fairly common occurrence, and are liable to arise wherever dirty oil from the joints and gearing of the machinery constantly comes in contact with the skin. In spinning mills this may be effected directly by the fine spraying of the oils from the spinners revolving in the oil cups, or indirectly from saturated clothing or cleaning rags. The condition is easily recognized by the stippled ground of minute, black, dilated follicles, upon which the typical rounded, well-raised, hard papules of a dusky red color are irregularly dotted. These papules vary in size from that of a hemp seed to that of a split pea, and are centered by a hair. They may become surrounded by a zone of erythema, or may develop into an acute boil. Usually, however, they are indolent lesions which form slowly, take many weeks to recede, and leave a pitted scar.

Collis (12), in England, reported fourteen cases of dermatitis in engineering shops among workers whose skin had been much irritated by cooling and lubricating mixtures consisting of turpentine and alkaline emulsions of mineral oil. This disease failed to appear when neither turpentine nor mineral oil was used.

R. P. White (1), discussing the effect of petroleum, says that in all instances in which raw petroleum is handled, the workers suffer, whether it be at the mines, refineries, pumps, or in the manipulation of the raw petroleum itself. He states that from 1890 to 1893 eighteen cases of petroleum acne were reported in French refineries, and in the official statistics, which included 1,380 petroleum workers in Russia, nine were reported to be suffering from general symptoms, and forty-three from petroleum acne. Rambousek (13) makes the statement that opinion is unanimous as to the injurious action of mineral oil on the skin, and particularly that the graver consequences are produced by the petroleum residues. The products of the distillation of petroleum and coal appear to have the same effect.

Oppenheim (3) has noted diseases of the sweat and sebaceous glands in paraffin and petroleum workers, who develop an "acne petrolei" most marked where the clothing is saturated with the heavy oils, especially on the "streckseite" of the arms and thighs. The heavy petroleum products are considered by him to be the most common cause of this trouble. He quotes Milliard as stating that half the men employed in the petroleum refineries in Rouen suffered from acne, most of them coming in contact with the heavy oils. He maintains that "Batschöl" and "Juteöl" produce the so-called "Weberakne," and that machine workers may suffer from "Schmierölakne."

Weichardt and Apitzsch (14) studied the cause of an outbreak, among the workers in the metal industry, of a skin disease consisting of small comedones and pustules which developed first on the hands and forearms, and later on other parts of the body. This disease became very serious among the machine workers, usually developing within approximately two weeks

after employment. The authors consider that the characteristic clinical picture may be ascribed to different causes and that in the beginning the local trouble may perhaps be due to an effect of the mineral oil which reduces the resistance of the skin and allows the entrance of secondary septic micro-organisms or their by-products. In studying their problem experimentally, Weichardt and Apitzsch found that machine oils applied to the ear of an albino rabbit caused severe inflammation. Olive oil rubbed on in the same manner had no such influence. Pure liquid paraffin was without effect, although the repeated application of pure mineral oil caused some irritation. On examination the machine oil was found to contain no free acids and alkalies. Although it contained 8 per cent. of resin, the oil still retained its irritating properties after the removal of this substance; it also contained a considerable amount of easily oxidizable substances and unsaturated compounds. The authors used several methods of saturating the oil by use of halogens but were not able to eliminate its irritating action upon the skin of rabbits.

C. J. White (15) states that "machinists of all sorts have a common enemy in dirty oil, which is rubbed into and absorbed by the follicles of the skin, and if boils don't follow, eczema may. The necessary cleaning at the end of the day's work adds its quota to the harm to which these men's skins are subjected. . . . Paraffin workers seem to be particularly prone to skin diseases. The substance harbors . . . many provoking ingredients, mostly mineral oils, and constant contact with this medium, with the consequent impregnation of the clothes, may produce eczema, pustules, and in the end cutaneous cancer."

Allworthy (16) mentions an acneform eruption of "doffers" in the flax spinning mills of Belfast. He states that the eruption is probably produced by dirt, sweat, and the sperm oil which is used on the machinery. In discussing this statement, MacLeod affirms that the acneform eruption is an example of oil acne, or *bouton d'huile*. "In it the follicles become plugged with a mixture of dirt and oil which causes inflammatory changes and produces the acneiform lesions. This condition is met with, not only in flax spinners but in any form of work in which the skin is liable to be bespattered with oil, such as in stokers, engineers, mill-hands, etc. It is a milder form of the dermatitis from petroleum, shale oil, etc., which tends to go on to warty growths and cancer. It occurs on the arms from the drops of oil and on the legs from contact with clothes saturated with oil."

Oppenheim (17) mentions serious irritations of the skin of the face from the use of impure vaseline salves which he employed in the treatment of lupus vulgaris. The skin became rough, harsh, uneven, warty, whitish and hard. Some of the softer nodules had a yellowish central point. This statement was discussed by Sachs (18), who affirmed that an acne-like eruption may develop alone or associated with eczema upon persons in contact with petroleum, tar, asphalt or pitch, and that Wacker and Schmincke in the Borst Institute had found forty-nine different substances (fats, oils, paraffin), which by experimental test gave rise to epithelial proliferation.

Deeds (19) investigated an outbreak of furunculosis among employees of a steel plant and found that "the epidemic apparently had its beginning in the case of the engineer at the plant, who was wont to clean his hands daily in the barrel of paraffin oil. Thereafter the cases appeared until each of the fifteen workmen had been so infected." The work done by these men was the handling of steel bars, which were coated with a mixture of paraffin oil and petrolatum to prevent rusting, and the hands of the men were constantly covered with this grease. Deeds considered that the

pyogenic organisms were carried from one man to another by the grease. *Staphylococcus pyogenes aureus* was isolated from the hands of the men but not from any of the grease used.

Thibierge (20) states that the *bouton d'huile* became so serious among the "tourneurs d'obus" that it made an actual difference in the functioning of the war factories. The lesions occurred in both men and women, most commonly on the hands and forearms, or on the face, if directly exposed to the lubricant, and on parts of the body exposed to oil-saturated clothing, especially the anterior aspect of the thighs. This trouble was generally most pronounced and extensive in individuals who had been employed for some time, and in the case of the "tourneurs d'obus" it became a veritable professional stigma. Necessity required the use of products of inferior quality and irritating nature (oil of petrol, etc.), and because of their scarcity it was impossible to purify them. They became charged with dirt and debris, which were deposited upon the skin and which clogged the mouths of the glands. The metallic particles were retained by the lubricating bodies, which in themselves were more or less irritating, and a special form of acne resulted. At this phase histological examination showed nothing of the follicular reaction. Finally the products of glandular secretion accumulated and became infected by pyogenic bacteria, and folliculitis and perifolliculitis developed.

Albaugh (21) states that furunculosis and wound infection "are unusually common in operators of lathes and cutting and milling machines, who come in contact with cutting compounds and cutting oils, where these lubricants are caused, by gravity or force, to flow in a steady stream on a job at the point of application of the tool. It has been observed, also, that these infections are more prevalent during the summer months, the exact reasons being unknown." Albaugh is not inclined to accept the idea that these affections are caused solely by the bacteria which are present on and in the skin, and which are allowed to set up an infection following injury by the oil; he believes rather that the oil itself may serve as a vehicle of the infectious material — a surmise which is further supported when the different types of skin affections are scrutinized as to their relation with the different substances.

Records of a three months' period showed forty-one cases of furunculosis and twenty-six cases of wound infection occurring in twenty-six departments of a factory employing 1,365 men, and probably many more cases were treated outside the plant. Few of these men had been troubled before coming in contact with cutting compounds or cutting oils. The men denied spitting into the reservoirs, although several of them were observed to do so in spite of instructions to the contrary. As the oils were collected from the machines and used again, this was an extremely dangerous practice. Albaugh goes on to say that "due to these exposures, pollution is almost certain to follow, especially in those cases where employees have acne or where they have pus infections of the skin, or mouth, or respiratory tract. This is most serious where machines are equipped with individual oiling systems, and where cuttings and shavings are collected from the different machines and the oil drained off and filtered.... This is also true of machined parts which are covered with oil and subsequently handled by men in other departments."

In his investigation among lathe workers of infections which appeared to be true pus infections, Shie (22) states that "a pinprick, if left unattended, developed into a severe lymphangitis; a slight scratch in twelve hours into a linear mass of pus; a slight abrasion into a suppurating ulcer; and a laceration into a mass of necrotic tissue and pus."

Blum (23) has recently submitted an article on the skin affections due to oil which he has called *élaiokoniose folliculaire (bouton d'huile)*. He states that it is not the oil which plays the most important rôle, but in reality the foreign bodies carried by the oil, metallic particles and dust, which contribute to the obliteration of the follicular orifices. The oil is thus the vehicle and not the pathogenic agent. It is to the dermatitis of this type that the author attributes the name *élaiokoniose folliculaire* (ἔλαιον, huile and κόνιος, poussière) — "a general name used to designate the special affection of the pilosebaceous follicules observed in laborers whose skins are greased by lubricating or other oils, or whose pores are impregnated and fouled by dust in suspension." The trouble appears gradually, first generally on the hands and postero-internal face of the forearms and on the backs of the fingers. It appears occasionally on the thighs and abdomen as a result of wearing clothes saturated with the oil, and sometimes on the face and neck of attendants on machines which throw the oil to some distance. More often the lesions on the face and neck are due to scratching or to the worker's passing his hands and forearms over his face to remove the sweat.

Type of Lesion Due to Oils

R. P. White (1) attempts to classify the effects upon the skin of petroleum and its distillates which, generally speaking, cause varying grades of dermatitis, roughly corresponding to the temperatures at which they are given off: (*a*) Benzine, or petrol naphtha (boiling point 150° C. and under), causes superficial inflammation of the skin, with dry, scaly conditions, or eczematous lesions showing fine vesicles, pimples or pustules. (*b*) Lighting oil (boiling point 150° to 300° C.) causes papular and pustular eczema, miliary folliculitis, with or without perifolliculitis (acne), and abscesses. (*c*) Residuum (boiling point above 300° C.) causes erythema, keratosis senilis—punctiform folliculitis, warts, ulcers, and carcinomata. "These appearances are not necessarily sequential the one upon the other, and mixed lesions prevail amongst the workers, especially in the distillates coming off at the higher temperatures."

Dr. White also states that the existence and intensity of a trade dermatitis depends upon three factors. In order of importance they are: (1) the potency of the irritant; (2) the resisting quality; and (3) the reactive capacity of the skin.

According to Besnier, Brocq and Jacquet (24), the acneform folliculitis, a pseudocomedo, is uniquely an appendage of trades in which are handled tars, petrols and the residues of their distillation known as heavy oils. They state that the vesicular and pustular dermatites are very frequently the origin of lymphangitis and adenitis which may result in suppuration. These complications are rare in spontaneous eczema.

Pusey (25) states that in addition to the irritants that produce the usual inflammatory reactions, there are certain substances that produce lesions in the skin which are not of the ordinary inflammatory type. The substances which do this especially are tar, mineral oils and greases, and their derivatives, and, perhaps, true fats. The commonest lesions which these substances produce are boils and large crops of blackheads and pustules. Such eruptions are seen not infrequently in men habitually exposed to these substances in their occupations.

Bridge (26) divides oil injuries into two classes — the first, the injury due to the plugging of the small glands at the root of the hairs; and the second, the mechanical injury produced by metallic particles suspended in the cutting lubricant. The former is primarily mechanical; the mixture of dirt and oil blocks the opening of the glands and, while secretion continues,

excretion is prevented and an inflammation is caused (folliculitis). The glands may be invaded by bacteria and suppuration results in a boil. Mechanical injury due to particles of metal suspended in the oil usually occurs on the hands, where two surfaces are rubbed together, or on the arms, from wiping with a cloth or waste when the skin is coated with a film of oil in which metal particles are suspended. This injury allows the entrance of bacteria from which infection may result. Often the oils become infected and thus spread the condition among the workmen.

Hubbard (27) states that an improper practice, and one which frequently causes skin diseases in mechanics, is that of spitting into oil receptacles or trade materials, which subsequently have to be used or handled by workmen. Oil infected by spittle, especially when used in lathe work, quite often causes boils. Grinders frequently blame the ingredients of preparations used by them, when investigation has shown that their trouble was due to careless workers spitting into the material.

The *bouton d'huile* in its most advanced stages is characterized by Thibierge (20) as a round pustule 2 to 6 or 8 mm. in diameter, generally little raised, with resistant walls enclosing a thick pus. This pustule is habitually surrounded by a narrow inflammatory, red, slightly infiltrated zone, and has little tendency to open spontaneously. Once having been opened, however, the orifice remains so for one or two weeks and the slight inflammatory zone surrounding the pustule disappears slowly. Besides this type of pustule, there are other longer pustules without infiltration at the base, which develop more rapidly and produce large quantities of pus. These tend to multiply by auto-inoculation and present many of the characteristics of a streptococcic erythema. This latter affection is not considered the same as the *bouton d'huile*. In many individuals there develop large numbers of acne comedones usually centered by a hair.

The affections described chiefly by Albaugh were true furunculoses and wound infections, which are apparently much more severe than the oil acne, *bouton d'huile* or *élaiokoniose*.

In his description of the *bouton d' huile*, Blum (23) states that in the beginning there is a slight itching. Little by little there develop numbers of black points which cannot be removed by washing, many of them presenting projections more or less pronounced, at the center of which the hairs appear old or broken. This stage corresponds to the obstruction of the follicles by dust (konioses) mixed with oil and develops into a veritable acne comedo. Later infection sets in, generally around the follicle, causing a perifolliculitis which clinically has the appearance of a pustule. These pustular lesions are red, violet or brown, sometimes "jambonné"; they are generally flattened, more rarely conical, and represent variable dimensions, from the size of the head of a pin to that of a pea. Some of the pustular lesions have a raised center containing a drop of yellowish pus centered by a black point; the papule has become a papulo-pustule. In other cases, there are vesico-pustules having a vesiculiform aspect. At other points the infection is a true folliculitis and more deeply seated, and in some cases true furuncles develop. There are thus, according to Blum, four stages, all of which may appear in the same patient at the same time: (1) the stage of the black point; (2) the stage of acne comedo; (3) the pustular and papulo-pustular stage; and (4) the furuncle stage. It is evident, then, from the above references, that the action of oils will depend upon the type and grade of oil, the conditions under which it is employed, the length of time it has been used, the kind and amount of microbial contamination and the kind and amount of dirt, dust and metal in suspension.

Influences Predisposing to Affection of the Skin

The structure of the skin renders it specially able to resist the action of agents likely to injur it and allow the invasion of micro-organisms. Its toughness and elasticity permit it to resist mechanical injury, while the chemical nature of its secretions prevents to a certain extent the action of chemical agents. In discussing this point, Jacquet and Jourdanet (28) make the statement "that one rarely finds traumatic eczema on the palms of the hands, where the sweat and grease are abundant and well mixed; that eczema is more common in winter [when the secretions are apt to be deficient]; and that an oily skin is less affected than a dry skin." This is not true in the case of affections due to oil, since they are more commonly reported in the summer than in the winter. This may be due to the fact that in the summer the follicles are more open and more easily clogged by the dirt carried by the oil, and that micro-organisms more easily penetrate into the follicles under these conditions.

There are certain factors which may predispose to infections of the skin, such as defective structure or function—congenital or acquired, permanent or temporary—or unusual environmental conditions. The age of the individual is also important. In the infant, ordinary soap may cause irritation, and in extreme age the skin is more easily injured and has less recuperative power than at earlier periods of life. Sachs (18) has shown, however, that the skin of old rabbits is much more resistant to the action of certain irritant aniline colors than the skin of young animals.

Abnormal activity of the sebaceous glands may predispose to injurious effects of certain substances such as oil, tar, and petroleum. Unnaturally profuse sweating is undesirable in certain industries, since there is increased tendency to retain the irritant on the skin and to increase its solubility.

R. P. White (1) states that an occupational disease once induced may predispose to recurrences of skin diseases not produced by the primary cause. Fordyce (29) maintains that in chronic skin diseases one of the most prominent features is the increased susceptibility which the skin either presents from the beginning, or which develops as the process advances. This may be referred to a state of anaphylaxis. Persons who show an increased susceptibility to irritants may, perhaps, be sensitized to the toxin of pyogenic organisms just as patients with tuberculosis may be sensitized to tuberculins. Such hypersensitive or abnormal skins are sensitive to small amounts of irritants not affecting normal skins and this condition may pave the way for the entrance of micro-organisms normally present on the skin or added by contact.

The French writers attach considerable importance to the influence of constitutional disarrangements in skin diseases. Thus, a skin poorly supplied with blood is more subject to the action of irritants and to invasion by bacteria. It is also well known that digestion and nervous disorders, alcoholism and diabetes mellitus affect the resistance of the skin to infection. In some clinical investigations in this connection, Jacquet and Jourdanet (28) found that the cure of certain gastric disorders was followed by great improvement in the severity of local traumatic skin troubles, and by the prevention of relapses. They claim that the careless bolting of food, especially if indigestible, can in itself exercise an injurious influence upon occupational eczema, proportionate to its severity. They also demonstrated that irritable conditions of the mucous membranes, and overdistension of the stomach are associated reflexly with pathological states of the skin.

Alderson (30), in discussing increased

vulnerability of the skin due to systemic conditions, states that "in considering the skin, we must not forget that it is an important organ intimately connected with and influenced by all the various bodily functions, among which the digestive system plays an extremely important part. Various disorders of the nervous system and internal gland system are often the cause of increased susceptibility of the skin to injury." In discussing increased vulnerability due to local conditions he declares that "a person whose skin is congenitally defective, particularly in the outer layers, is very much more liable to develop trade dermatoses than one with a normal epidermis. . . . A deficiency in secretion is liable to result in lowered tone and lowered resistance to chemical and mineral irritants as well as to atmospheric and thermal conditions. On the other hand, an excessive sebaceous secretion is prone to clog the follicles and the ducts resulting in increased irritation and vulnerability. Skin of this sort is usually favorable soil for bacterial growth. It is particularly sensitive to the deleterious effects of various oils, tars, paraffin, petroleum and allied substances."

Skin diseases in general, and those due to oils in particular, are considerably influenced by secondary invasion by micro-organisms, and according to Besnier, Brocq and Jacquet (24) it is correct to say that the secondary micro-organisms determine the character of the dermatosis.

Bender, Bockhart and Gerlach (31) and Bockhart (32) studied the influence of staphylococci and their products upon the skin of man. They found that "toxin" obtained from broth cultures, when applied to the skin, caused eczema alone; while "plasmin" from the cells of the organisms, applied to the skin, caused pus formation. Bockhart states that the inactive staphylococci in the sound follicles of the skin, due to some inner or outer condition of the body which improves their nutritive conditions, increase their activity. This results in the excretion of the toxin which diffuses into the epidermis giving rise to a serotactic action and the formation of vesicles and papules. The tissues in the immediate neighborhood of these lesions contain only clear serum and no organisms. After a time the organisms increase and invade these areas. If the organisms contain sufficient "plasmin," leukocytes wander in and the process becomes pustular.

The fact that non-virulent staphylococci from the skin can become virulent has been proved by Geisse (33). He obtained three strains which were non-virulent, non-hemolyzing, non-pigment forming, and which would not agglutinate with serum agglutinating pathogenic strains. These were placed in collodion capsules and placed within the peritoneal cavities of guinea-pigs. After a passage of three or four animals they acquired pathogenic, hemolyzing and pigment-forming properties and were agglutinated by serum specific for pathogenic strains in high dilutions.

There is no doubt that most of the skin affections are due to the staphylococci, although Weichardt and Apitzsch (14) mention isolating streptococci from the lesions of machine shop workers, and Oliver and Schwab (34) isolated from a patient having furunculosis an organism which they considered belonged to the colon-typhoid group.

Bacteriology of Oils

A review of the literature shows that very little attention has been given to the bacteriology of oils. Deeds (19) made a bacteriological examination of oil, petroleum, and grease mixtures, and in five out of six examinations he found *Bacillus subtilis*, or air-borne bacteria, but succeeded in isolating no pyogenic organisms. He also examined these products to determine their effectiveness as a medium for bacterial

growth and as germicidal agents. A twenty-four-hour culture of *Staphylococcus pyogenes aureus* was added and the suspension allowed to stand at room temperature for ten hours. Each hour a loopful of this material was transferred to 10 c.c. of nutrient agar and plates were poured. The result of this test showed that there was neither an increase nor a decrease in the number of bacteria during that period.

Albaugh (21) reported the examination of eight samples of oils and cutting compounds procured from machines, and from which cultures were made as follows: "slants of glycerine-agar and blood-serum were treated with a loop of each sample, as were plates of glycerine-agar. At the end of twenty-four hours all of the cultures had visible bacterial growths. These were found to be the usual pus-forming organisms. One sample showed as many as 110,000 micro-organisms per gram of oil (estimated from colonies in Petri plates after incubation for thirty-six hours)—the organism being practically a pure culture of *Staphylococcus aureus*."

Experimental Work

In the present investigation cultures were first made on plain agar, one set of plates being incubated at 25°C., and the other at 37°C. The types of organisms appearing on the plates were the same in both series. A few loopfuls of oil were suspended in agar and heated at 80°C. for twenty minutes, and plates made. No growth occurred. Eosin-methylene-blue plates were inoculated and one set incubated aërobically, the other, anaërobically over metallic phosphorus. Good growth was observed on the aërobic plates in forty-eight hours, and from these Types I and II mentioned below were isolated. Type III did not appear on these plates for several days, but gradually grew somewhat scantily. This type also grew somewhat better at room temperature than at incubator temperature. The anaërobic plates showed only Types I and II, Type I greatly predominating.

From deep agar shake cultures only Types I and II were isolated. No obligate anaërobes were obtained by any of the methods used. Cultures obtained by enriching in dextrose broth, lactose broth, and dextrose broth containing meat, all gave rise to Types I and II. Type III was evidently overgrown in these cases.

The organisms isolated were as follows: Type I, *Bacillus aërogenes;* Type II, *Bacillus coli communis;* both of fecal type as described in the Standard Methods for Water Analysis for 1917. The former gives all the typical reactions of the *Bacillus aërogenes* group, is alkaline to methyl red, gives a positive Voges-Proskauer reaction and ferments adonite. Type II gives all the typical reactions of *Bacillus coli communis*, is acid to methyl red, negative to the Voges-Proskauer reaction, and does not ferment adonite. Type III is a Gram-negative, non-spore forming, actively motile rod with an average of about twelve flagella of peritrichic arrangement. It liquefies gelatin, and digests casein and Löffler's blood serum very rapidly. It is very similar to the liquefying *Proteus vulgaris* strains, but produces neither acid nor gas in any of the fourteen carbohydrates tested. The final hydrogen ion concentration in Clark and Lubs' medium dextrose broth and peptone solution was about 8.2. It gives a negative Voges-Proskauer reaction and did not produce indol.

Tests were made of the thermal death point of these organisms suspended in normal saline solution as well as in the oil from which they were originally isolated. The mixture was drawn into capillary tubes, which were sealed at each end and placed at temperatures indicated in Table 1. At the end of the exposure the tubes were removed, placed in a 5 per cent. solution of phenol for fifteen minutes, then in 95 per

cent. alcohol for fifteen minutes, and then allowed to dry in a sterile Petri dish. The ends were then broken off with sterile forceps and the contents allowed to flow out into sterile plates to which agar was added. Table 1 shows the results obtained.

Bacteria seem to be able to retain their vitality in oil for long periods of time. The sample of oil investigated has been in this laboratory for eight months and still contains as many bacteria as when it was received. One interesting point is that while there were typical fecal types of bacteria present in the oil, yet no spore-forming types or staphylococci could be isolated.

TABLE 1. — THERMAL DEATH POINT OF ORGANISMS

Time of Heating at 60° C.	Type I	Type II	Type III	Oil
minutes				
5	+	+	+	+
10	+	+	+	+
15	+	+	−	+
20	+	−	−	+
25	−	−	−	−
30	−	−	−	−

Time of Heating at 70° C.	Type I	Type II	Type III	Oil
minutes				
5	+	−	−	+
10	−	−	−	+
15	−	−	−	−
20	−	−	−	−

Kurpjuweit (35) studied the length of time that bacteria could retain their vitality in olive oil and reported the following:

Staphylococcus aureus not obtained after 12 days
Bacillus coli " " " 14 "
Bacillus diphtheriae " " " 9 "
Bacillus pyocyaneus " " " 14 "
Micrococcus ureae " " " 11 "
Bacillus typhosus " " " 14 "

Studies on the influence of desiccation in air and in vacuum were made by Hammer (36) who found that *Bacillus coli* when desiccated in air over sulphuric acid died in two days. When desiccated in vacuum it lived for fifty-seven days (end of test). *Staphylococcus aureus* gave no growth in two days in air and growth after fifty-four days in vacuum. *Bacillus pyocyaneus* gave no growth after four days in air, nor after seventeen days in vacuum.

In the present investigation, tests were made to determine the length of time these organisms would retain their vitality upon the ordinary artificial media. The results are shown in Table 2.

Pathogenicity.—One c. c. of a forty-eight-hour broth culture of these organisms was injected intraperitoneally into guinea-pigs of the following weights: Type I, 564 gm.; Type II, 509 gm.; Type III, 539 gm. The pig receiving Type I was dead in twenty-four hours and a pure culture of the organism was obtained from the peritoneum, liver and heart blood. The animals receiving Types II and III showed no ill effects,

TABLE 2. — LENGTH OF TIME ORGANISMS RETAIN VITALITY UPON ARTIFICIAL MEDIA

Culture Medium	32 Days			60 Days		
	Type I	Type II	Type III	Type I	Type II	Type III
Litmus milk	+	−	+	−	−	+
Dextrose broth	+	−	+	+	−	+
Peptone solution	+	+	+	+	+	+
Agar slant	+	+	+	+	+	+

excepting that the Type II pig appeared sick for about forty-eight hours.

Relation of Organisms Isolated to Furunculosis. — The particular sample of oil in question was submitted to this laboratory as it was considered to be the cause of boils. All attempts to isolate pyogenic organisms failed, and since the oil was drawn directly from the supply barrel and was not exposed to dust, it is doubtful if any of these or-

ganisms were present. As it is well known that the ordinary staphylococcus types are quite highly resistant to external conditions, it is also doubtful if they would have disappeared and left the colon type in such large numbers and such vigorous condition. It is indeed difficult to understand how such tremendous numbers of organisms of the type isolated could have been present in the oil without direct fecal contamination.

From our tests the oil could not be incriminated directly as being the cause of the disease. The tests are, nevertheless, of considerable significance in showing how long organisms can live in oil and still retain their virulence. We may here again emphasize the point so often mentioned by others, that workers should use great care not to contaminate the oils which are to be used again, and not to use waste and rags with which others have wiped their hands.

Treatment of Oil to Reduce Danger of Infection

It does not necessarily follow that infection of the skin will result from the use of oil contaminated by pus-forming bacteria. As was mentioned in the first part of this article, certain oils are naturally somewhat irritating to the skin, while others may contain particles of metal which cause injury. Also, some individuals are predisposed to infections of this type. In order to eliminate possible danger of infection, therefore, the oil should be handled with precaution. The workmen should be warned against spitting into it since pyogenic organisms are very common in the mouth and saliva, and persons with skin affections of any kind should not be allowed to come in contact with the oils or cutting compounds used by others. The heating of the oil to 70° C. for twenty or thirty minutes will destroy all the dangerous types of bacteria, and by allowing it to stand for a short time the particles of metal will settle out and may be discarded. The individual cleanliness of the worker himself and the care of his hands will also reduce the danger of infection.

Boils cannot be entirely eliminated, however, especially in those who are predisposed to irritation, and whose skins are little resistant to the irritating action of oil and bacterial invasion, since organisms of the type commonly causing boils are very common on the skin. Thus, irritation or injury merely aids their entrance.

Summary

1. Oils of all types are likely to produce skin affections if they come in contact with the skin for some length of time.

2. The most serious skin diseases are probably due to the oil acting as a carrier of infectious material from one individual to another.

3. Individuals of the most cleanly habits are, generally speaking, least liable to skin affections due to oils.

4. Special care should be exercised by workmen on cutting machines to avoid contamination of the oil, especially by spittle.

5. Individuals having skin diseases should be transferred to some other type of work.

6. While oils may be placed on the market in a sterile condition and free from dust, etc., they will not long remain so after being put into use.

7. By heating the oil to 70° C. for twenty or thirty minutes, it is possible to destroy all the dangerous pathogenic bacteria likely to be present.

8. It would seem very desirable to use oil which has been rendered free from dust, and especially from particles of metal.

9. Workmen should not exchange waste and rags used in cleaning their hands, and should not bathe their hands in the oil.

10. Clothing saturated with oil should not be worn, especially if there is an epidemic of skin diseases among the workers.

Note. — After this paper was accepted for publication, the *Editor* called the attention of the writers to the report of an investigation by the research staff of E. F. Houghton & Company on the *Causes of Skin Sores and Boils among Metal Workers* (37). Data are given in detail and the results of the investigation are summarized in non-technical language. These results show:

1. Ichthyol (0.2 per cent. to 1 per cent.) contained in certain oils produces skin lesions.

2. The oils pressed from crude solid paraffin also contain an irritating substance.

3. Lard oil does not irritate but may contain bacteria.

4. Houghton's non-irritating blending oil is almost entirely free from ichthyol and from organically combined hydrocarbon sulphonate. It is free from paraffin wax and contains no other ingredients which would irritate the skin.

5. Daily filtration of used oil (140° F. for thirty minutes) combined with sterilization will reduce the number of metal particles and the danger of bacterial contamination from careless workmen.

6. Germicides added to oil are not efficient or satisfactory.

7. The cleanliness of the worker is of first importance. Education in cleanliness is needed.

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BOOK REVIEWS

Public Health and Insurance: American Addresses. By Sir Arthur Newsholme, K.C.B., M.D., F.R.C.P., Lecturer on Public Health Administration at the School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland; Late Principal Medical Officer of the Local Government Board, England; President of the Society of Medical Officers of Health and of the Epidemiological Society; Examiner in Public Health to the University of Cambridge, in Preventive Medicine to the University of Oxford, and in State Medicine to the University of London, Member of the General Medical Council, of the Council of the Imperial Cancer Research Fund, etc. Cloth. Pp. 270 with index. Baltimore: The Johns Hopkins Press, 1920.

In the form of ten lectures Sir Arthur Newsholme has brought together material presented by him in addresses to various public audiences in the United States and Canada, and particularly to students in the School of Hygiene and Public Health of Johns Hopkins University during the year 1919–1920. It is fortunate that there are thus made available to a larger public these expressions of the philosophy and wisdom of an able and broad-visioned public health administrator.

The lectures are concerned essentially with the development of public health activities in England, and it is, therefore, inevitable perhaps that there should be extended discussion of the relation of public health administration to the Poor Law authority and of the interrelations of poverty and disease.

Dr. Newsholme's views regarding the English National Insurance Act would undoubtedly interest any person who has given thought to the problems of compulsory health insurance. "The chief justification of a national system of insurance against sickness is that it shall be an action auxiliary in the prevention of disease. . . . Health progress can only be secured by preventing preventible illness. . . . In securing such a result there will be needed medical practitioners who are imbued with the ideas of preventive medicine in its widest sense. . . . There is needed a reconstruction of the training of each medical student which will make preventive medicine in its widest sense an integral part of his training. . . ."

This very readable book well merits the attention of all who believe that "the real wealth of a nation does not consist in its money, in the volume of its trade, or in the extent of its dominion. These are only valuable in so far as they help to maintain a population — and not only a portion of it — of the right quality: men, women, and children possessing bodily vigor, alert mind, firm character, courage, and self control"; and that "this ideal can never be realized unless and until the medical men of the future train themselves for and devote themselves to their essential share in its fulfillment." — *Wade Wright.*

Die Kohlenoxydvergiftung. Ein Handbuch für Mediziner, Techniker und Unfallrichter. By Professor Dr. L. Lewin. Paper. Pp. 369 and a spectroscope chart. Berlin: Julius Springer, 1920.

This book is by the well-known Berlin toxicologist, who has written many articles on carbon monoxide poisoning in current medical literature. The subject is dealt with exhaustively under the following headings: history; sources of carbon monoxide; physical and chemical properties; relation of carbon monoxide to the tissues of the body; qualitative and quantitative tests; mode of action on plants, cold-blooded and warm-blooded animals; rôle of individual susceptibility in poisoning; mode of absorption; sources of carbon monoxide in industry; acute poisoning and its sequelae; chronic poisoning; pathological anatomy and medico-legal aspect; statistics; prophylaxis and treatment.

The chapter on history opens with the statement that carbon monoxide is now and has been since the first discovery of fire the most widespread poison connected with human life and activity. Aristotle mentions coal gas as a cause of death. Livy and Valerius Maximus describe wholesale executions performed by imprisoning the victims in the public baths and then starting the fires, and it seems also to have been a common method of painless suicide in Roman days. Julian, the Apostate, describes a very typical case of poisoning which he suffered when sleeping in a room with a pan of glowing coals. Through the Middle Ages the history of carbon monoxide poisoning passes from one extreme to the other. Sometimes its effect is attributed to the work of demons or witches; again, an unusually observant and clear-headed physician will describe a case with great accuracy. Avicenna noted it as a poison which weakened the brain. Toward the latter part of 1500, Donato of Mantua described practically all the symptoms of this form of poisoning, the rosy color of the face and the appearance of nor-

mal sleep in the coma of carbon monoxide victims, the fever, bronchial irritation, and pneumonia which follow, and the different manifestations of damage to the brain. More than a hundred years later, Ramazzini described carbon monoxide as a common industrial poison, and the eighteenth century saw the publication of several very accurate observations, notably those of Friedrich Hoffmann in 1720 and of Boerhave in 1732.

The author gives analyses of smoke and gas from all possible sources, and the student who wishes to look up "gassing" in mines, in the use of explosives, in blast furnace work, in the use of power gas, and in the manufacture and use of illuminating gas will find much valuable material here. In the section on the physical and chemical properties of carbon monoxide, Lewin warns against the fallacy of applying to human beings the facts discovered in the laboratory, for in this form of poisoning, more than in any other, individual characteristics play an enormous rôle. The outcome of no single case can be predicted on the findings with regard to concentration of carbon monoxide or absence of oxygen; the man's fate lies essentially in his own vital forces. Even the capacity of the blood to bind carbon monoxide varies in different individuals. A practical point brought out by test tube experiments is that, although the blood gives up carbon monoxide even at zero centigrade, the surrender is much more rapid at a higher temperature.

It is impossible to cover nearly all the chapters of this book within the compass of a review. There is space only for the stand taken by Lewin on various controversial points. He finds carbon monoxide excreted very rapidly during the first hour after removal to fresh air, then more slowly, but by the end of six hours it is usually no longer demonstrable, although he has satisfied himself that as little as 0.25 per cent. can be shown through the spectroscope. He is very skeptical about the instances reported in the literature of carbon monoxide in the blood after more than twenty-four hours in pure air. The great variation in the quantity found in the blood after death (from 6 per cent. in Emile Zola's blood to 83 per cent. in one of Haldane's cases) can only be explained on the ground of individual susceptibility or perhaps of difference in the mode of administration of the gas, or the possibility that blood in different parts of the body contains different proportions of carbon monoxide.

Lewin takes a very positive stand in the controversy over the mode of action of carbon monoxide, denying that there is any direct action on the cells of the central nervous system or of any other organs. All the manifold lesions found after carbon monoxide gassing result from the injury caused by oxygen privation. The whole error of those who uphold the theory of carbon monoxide as a protoplasmic poison is that they do not distinguish between the lesions of acute poisoning and the later results which have no direct connection with the intoxication but are secondary and of various origins. It is absurd to say, when pneumonia supervenes twenty-four to forty-eight hours after the intoxication, that carbon monoxide has injured the lung, for it has no chemical or physical effect on lung tissue nor does it injure the blood vessels, producing fatty changes of intima and media, any more than does the inhaling of amyl nitrite. Carbon monoxide poisoning is a special kind of asphyxia which in general corresponds symptomatically with other forms of oxygen deprivation. This statement rests on the blood changes noted and on the impossibility as yet of finding any other tenable theory. If the blood changes are not the essential and only cause, then the action of carbon monoxide on the brain must be relegated to the mysterious realm of morphine, hydrocyanic acid, cocaine, etc., which have nothing in common chemically and yet affect the function of the brain in some unexplained way. With carbon monoxide as with hydrogen sulphide and with the poisons which form methemoglobin, there is a *causa proxima* in the blood changes, and this should be accepted so long as no more cogent cause can be found.

Carbon monoxide poisoning is, however, distinguished from all other oxygen-deficiency or hemoglobin-alteration poisons by the occurrence of sequelae. In all toxicology no known body can compare with carbon monoxide in the variety and extent of lesions following it, and individual susceptibility is not enough to account for them. But to assume that carbon monoxide acts directly on the brain and other organs does not help, for in that case the effects would be more uniform and constant. Their great variation and extent show that very special conditions must be present, not accounted for by mere oxygen deficiency or other poisons, and it is these conditions that are the most puzzling elements in the problem of carbon monoxide poisoning.

To the unsettled question of chronic carbon monoxide poisoning Lewin does not contribute very much, although he gives some instances of marked and undoubted slow poisoning. It cannot be regarded as a cumulative effect of the gas in the body which, when it reaches a certain degree, gives rise to clinical symptoms. For this, one would have to remain in the carbon monoxide atmosphere continuously, and that is never true; one is always getting rid of the gas when one goes out into pure air. A chemical accumulation cannot occur, but a functional one can — *i. e.*, a cumulative effect of all the injuries done to the blood and to the tissues, especially the hemopoietic. This injury may be simply nutritive — an anoxemia — but as a result poisonous products may be formed and exert their own secondary action. As in acute poisoning, individual susceptibility varies greatly. There is great difficulty in diagnosis, for the symptoms are usually only headache, anemia, cardiac neurosis, or general nervousness. The avocations in which this danger is present are these: cooks, furnace tenders, pressers, laundry workers, gas workers, molders, miners, chemists, firemen, garage workers and housewives. The symptoms which come on usually at the end of the day's work — headache, dizziness, and disturbance of vision — pass over quickly at first in the open air, but later the natural recuperative powers fail and some form of chronic poisoning sets in, the most common of which is anemia, which may be of any type up to the severe pernicious.

The treatment of acute carbon monoxide poisoning must be directed toward the restoration of normal response to stimuli on the part of the cerebral centers, especially the respiratory. The ground for administering oxygen is the fact proved by experiment that the dissociation of carbon monoxide from the blood takes place five times as quickly with pure oxygen as with ordinary air. The administration must sometimes be prolonged, but it is necessary to remember that with the disappearance of carbon monoxide from the blood the symptoms caused by its presence do not always disappear. The brain symptoms, for instance, may not improve, even after all the carbon monoxide has vanished, and one must assume either that there are other toxic substances present in the blood which continue to act, or that the degenerative changes set up by carbon monoxide progress after the cause has been removed. Lewin condemns unreservedly the subcutaneous injection of oxygen or hydrogen peroxide. He approves of venesection as lessening the danger of hemorrhage, stimulating blood regeneration, and also as effecting a partial removal of the poison (*Teilentgiftung*), which last is hardly in harmony with his repeated assertion that carbon monoxide is not a poison. Normal salt infusion is of decided value, especially when preceded by bleeding, but Lewin objects strenuously to blood transfusion, apparently under all circumstances.

A colored chart of the different spectra of oxyhemoglobin and carbon monoxide hemoglobin before and after reduction is appended. The bibliography is very full, in fact, practically complete except for the more recent American publications which were probably not accessible to the author at the time of writing. — *Alice Hamilton.*